Service Manual
Engine 601

Mercedes-Benz
service

Mercedes-Benz of North America, Inc.
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Montvale, NJ 07645

Caution

Our service manuals contain descriptions of important assembly, adjustment and inspection jobs. Special tools required in performing certain service jobs are identified in the manual and recommended for use. Any part numbers given are only used for identification and easier differentiation between individual components, and are not intended for ordering purposes.

All procedures, illustrations and specifications contained in these manuals were based on the latest information available at the time of publication. If your Mercedes-Benz model differs from the specifications contained in the manual you select, consult your authorized Mercedes-Benz dealer.

Remember, the proper performance of services is essential for both the safety of the mechanic and the efficient operation of the vehicle. The procedures in these manuals are described in such a manner that the service may be performed safely and accurately.

However, it is always assumed that the reader is familiar with basic automotive repair procedures and Mercedes-Benz vehicles.

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Introduction

This Service Manual is the product of existing technical publications. Special care has been taken to provide accurate information on removal, disassembly, assembly, inspection, installation, and adjusting procedures, backed with the technical data necessary to do the job.

The material in this manual is divided according to the Mercedes-Benz Component Group System as outlined on the GROUP INDEX page. This page will quickly direct the reader to the Major Component Group. Each Major Component Group begins with a JOB INDEX listing all jobs within that group.

Mercedes-Benz of North America, Inc. recommends that repairs to, and maintenance of, Mercedes-Benz automobiles be performed only by Mercedes-Benz trained personnel at authorized Mercedes-Benz dealerships.

The information contained in this special publication is ordinarily issued by Mercedes-Benz of North America, Inc., in conjunctionwith supplementary service literature and special tools supplied only to its authorized dealers. The repair and maintenance procedures outlined herein are procedures to be used by trained Mercedes-Benz **service and dealership personnel.** Supplementary service literature will not be provided with this publication, but may be contained in reprints of this Service Manual.

Please note that this manual has been compiled from various sources, some of which cover models other than the subject of this book. Always refer to the engine and vehicle identification table for model and component information.

The information contained in this manual was accurate to the best of our knowledge at the time the manual was approved for publication. However, the right is reserved to make production, design and specification changes at any time, without notice and without obligation to give notice. Any such changes will not be contained in this manual.

Mercedes-Benz of North America, Inc. assumes no liability for any damage to person or property caused by the utilization of this publication to effect maintenance or repair work on Mercedes-Benz automobiles.

MERCEDES-BENZ OF NORTH AMERICA, INC.
Technical Publications

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Complete Service Manual coverage for late model year Mercedes-Benz vehicles requires four individual manuals:

Service Manual, Engine
Service Manual, Transmission
Service Manual, Chassis and body
Service Manual, Heating and air conditioning

Throughout these manuals, the vehicles are identified by their chassis and engine numbers. These numbers are made up of the first six digits of the respective serial number. For the actual location of chassis and engine numbers, see page 00–015/1. In case where the repair instructions apply to all versions, only the first three digits of the respective number are referenced

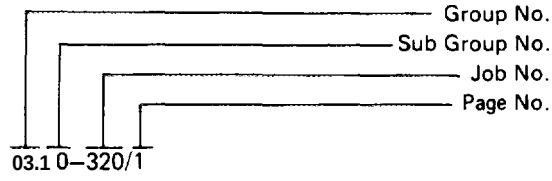
For example, engine 601 applies to all 601 engines. However, engine 601.921 would only apply to the engine used in model 190 D-2.2.

Location of specific repair instructions

First locate the Group No. in the Group Index. Individual groups are separated by an easily visible dividing page, which is followed by the job index page. Then check the job index for the exact job required. The first page of a typical job description looks like this:

03-320 Mounting of crankshaft

Job Title appears on same line as Group No.



Technical data, tightening torques and tools are listed at the beginning of each job.

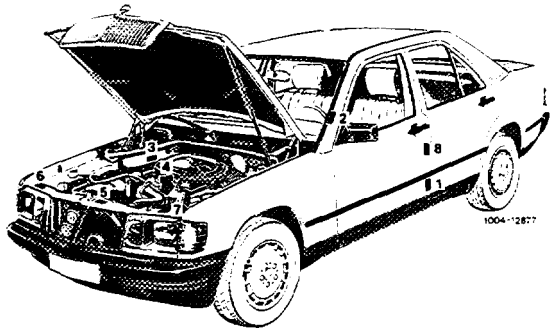
All dimensions are in metric units, unless otherwise indicated. Any part numbers given are only used for identification and easier differentation between individual components, and are not intended for ordering purposes.

00 Engine and vehicle identification

This manual applies to the following passenger cars, starting model year 1984:

Model	USA Model Year From	To	Chassis Type	Engine Type
190 D-2.2	1984		201.122	601.921

Vehicle identification number locations 00



1 Certification Tag [left door pillar)
2 Identification Tag (left window post)
3 Chassis No.
4 Engine No.
5 Body No. and Paintwork No.
6 Information Tag
California version
Vacuum line routing for emission control system
7 Emission Control Tag
8 Emission Control Tag
Catalyst Information

Engine		
Model		201.122
Engine		601.921
Operation		4-cycle diesel, ME prechamber design
Number of cylinders		4
Cylinder arrangement		In-line, 15" inclination
Bore/stroke	mm	87192.4
Total effective piston displacement	cc	2197
Compression ratio		22
Firing order		1 - 3 - 4 - 2
Maximum speed, no load	rpm	4900-5100
Engine output	kW/rpm SAE net bhp/rpm	54/4200 72/4200
Maximum torque	Nm/rpm SAE net. lbf-ft/rpm	130/2800 96/2800
Crankshaft bearings		5
Valve arrangement		Overhead
Camshaft arrangement		1 overhead camshaft
Oil cooler		–
Cooling		Water circulating pump, thermostat with bypass line, finned tube radiator, fan with electromagnetic clutch
Lubrication		Forced-feed lubrication via gear-type pump
Oil filter		Combined main and bypass filter
Air cleaner		Dry air cleaner with paper cartridge

00 Technical data

Electrical system

Battery	Voltage Capacity	12 v 72 Ah
Starter	Bosch	EV 12 V 2.2 kW
Alternator	**Bosch**	**KI-14 V 55A 20[1])**

[1]) As of model year 1985, a Bosch alternator 980 W 114 V 70 A) is installed

Filling capacities

Model				**201.122**
Engine				**601.921**
Fuel tank/reserve			approx. l	55/7.5
Engine	Initial filling	Engine oil	approx. l	7.3
	During oil and filter change	Engine oil	approx. l	6.5
	Oil pan up to marks on oil dipstick	Engine oil	max./min. l	5.0/3.0
	Air-oil cooler	Engine oil	approx. l	–
Cooling system with heater		Coolant	approx. l	8.5
Coolant pump				maintenance-free
Brake system		Brake fluid	approx. l	0.35
Manual transmission		ATF	approx. l	1.5
Automatic transmission		ATF Initial filling/ Oil change	approx. l	6.6/5.9
Rear axle hypoid gear oil		SAE 90	approx. l	0.7
Power steering		ATF or manual transmission oil	approx. l	0.6

01 Crankcase and cylinder head

	Job No.
Engine	
Checking compression pressure.	01–010
Checking cylinder for leaks	015
Evaluating cylinder bores	020
Removal and installation of engine (oil capacity)	030
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Operation	040
A. Standard version and (USA) Federal starting 1984	
8. (USA) California starting 1984	
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Timing housing cover and cylinder crankcase cover	
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Oil pan	
Removal and installation of oil pan	310
Cylinder head	
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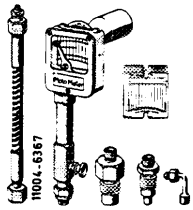
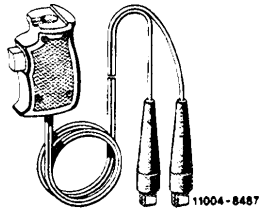
Removal and installation of cylinder head	415
Removal and installation of prechambers	417
Facing cylinder head parting surface	418
Pressure-testing cylinder head	420

01-010 Checking compression pressure

Test values with engine at operating temperature in bar gauge pressure	
Compression pressure, normal	24-30
Minimum compression pressure	approx. 15
Permissible difference between individual cylinders	max. 3

Tightening torques	Nm
Coupling nuts of injection lines (reference value)	1 O-20
Injection nozzles in prechambers	70 + 10

Special tools

Compression pressure recorder with accessories	 11004-6367	001 5894721 00
Contact handle for rotating engine (component of compression pressure recorder 001 589 46 21 00)	 11004-8487	001 5894621 08
Box end wrench element, open, 14 mm, 1/4" drive, for coupling nut of injection line	11004-10520/1	000 589 770300

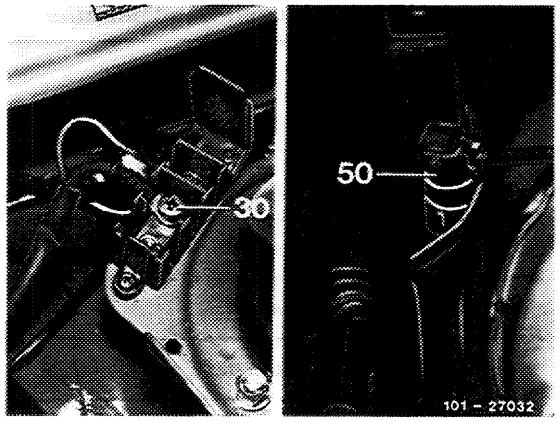
Note

Check compression pressure at 80 °C coolant temperature. Compression pressure can be checked only via prechambers. If minimum compression pressure is less than specified, check cylinders for leaks (01–015).

Checking

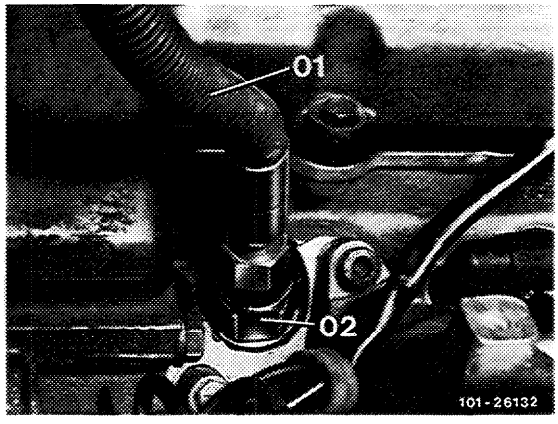
1 Remove injection nozzles (07-230).

2 Connect contact handle for rotating engine to cable connector, terminal 30 and 50, on fire wall.



3 Rotate engine several times with transmission in idle position, so that residue and soot are thrown out.

Attention!
While rotating engine, push stop lever downwards by means of an extension, so that the injection pump is not injecting.



Compression pressure recorder, connected to prechamber

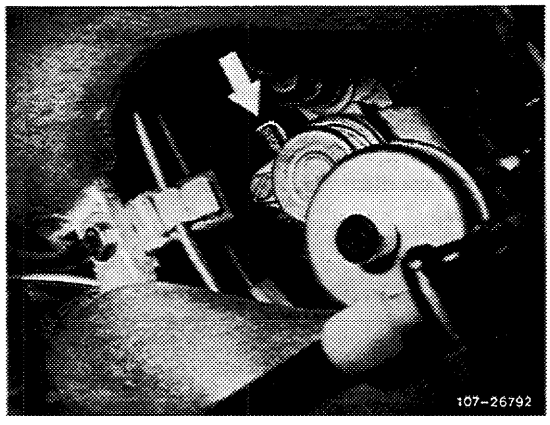
01 Compression pressure recorder
02 Connection

4 Screw adapter (component of compression pressure recorder) into prechamber. Connect compression pressure recorder.

5 Rotate engine 8 times for checking engine.

Attention!
While rotating engine, push stop lever downwards by means of an extension, so that the injection pump is not injecting.

6 Install new nozzle reeds prior to installing injection nozzle.



01-015 Checking cylinders for leaks

Data	
Total pressure loss	max. 25 %
On valves and cylinder head gasket	max. 10 %
On pistons and piston rings	max. 20 %

Tightening torques	Nm
Coupling nuts of injection lines (reference value)	**1 O-20**
Injection nozzles in prechambers	70+10

Conventional tools

Cylinder leak tester	e.g. Bosch, EFAW 210 A SUN, CLT 228
Couplings or connections	e.g. Bosch order no. 1 687 010 016

Checking

1 Run engine up to operating temperature.

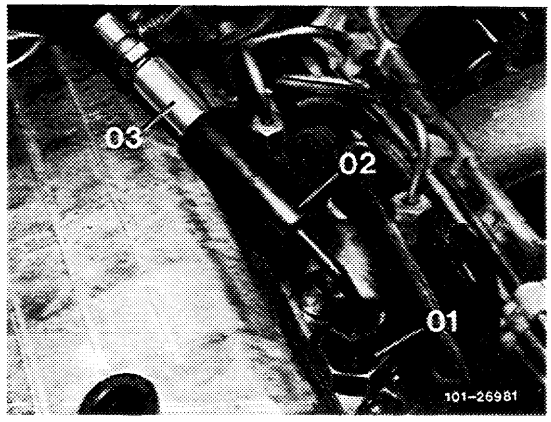
2 Remove injection nozzles (07-230).

3 Remove air cleaner cover.

4 Remove oil filler cap.

5 Remove radiator closing cap and fill up with coolant.

6 Screw adapter (01) and angle piece (02) into prechamber of 1 st cylinder.



01 Connection
02 Angle piece
03 Connecting hose

7 Set piston of 1st cylinder to ignition TDC.

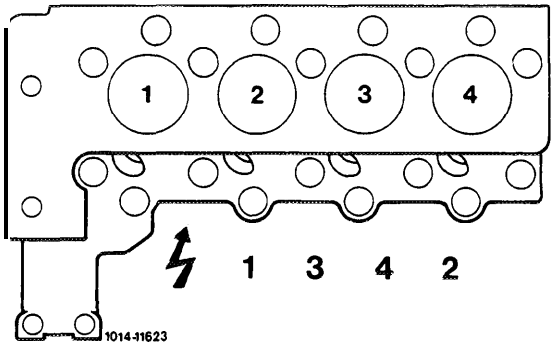
8 Connect cylinder leak tester to a compressed air system, calibrate tester.

9 Screw connecting hose (03) of tester to screw-in member. Make sure that crankshaft is not rotating **while screwing in hose.**

10 Read pressure loss on tester.

11 Check by listening whether the pressure escapes via intake manifold, exhaust, oil filler cap, pre-chamber of adjacent cylinder or radiator cap.

12 Check all cylinders in ignition sequence.



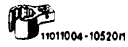
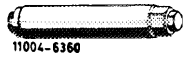
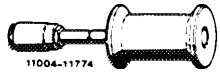
Note: There is a possibility that the piston ring gaps of the individual pistons are directly one above the other, so that the test result will be misrepresented.

When in doubt, continue running vehicle and check cylinders for leaks once again later on.

01-020 Evaluating cylinder bores

Tightening torques	Nm
Coupling nuts for injection lines (reference value)	1 O-20
Hex. head bolt for cylinder head cover	10
Threaded ring for prechamber in cylinder head	100 ± 10
Injection nozzle in prechamber	70 + 10

Special tools

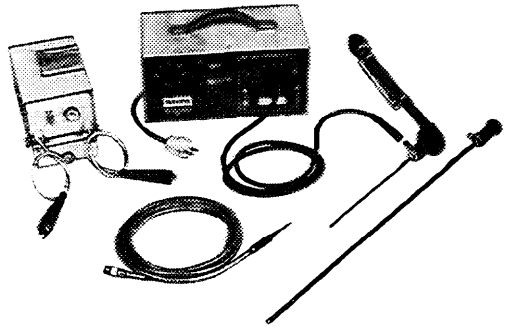
Box end wrench element, open, 14 mm, 1/4" drive, for coupling nut of injection line	 11011004-10520n	000 589 77 03 00
Wrench element for threaded ring of prechamber	 11004-6360	615589000700
Impact puller for prechamber	 11004-11774	601 589 06 33 00

Conventional tool

Cylinder illuminating lamp	e.g. Karl Storz GmbH, D-7200 Tuttlingen Motoskop TW (cold light) with lens probes 103 26 CW (570 mm) and 103 26 CT (210 mm)

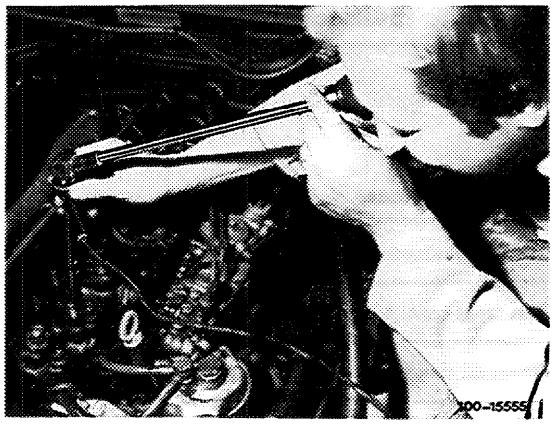
Note

The visual checkup can be made by means of a cylinder illuminating lamp with cylinder head mounted. Remove prechambers for this purpose (01-417).



103-15713

When evaluating scored or streaky cylinder running surfaces, it is often hard for workshop to decide whether the damage is already significant and requires removal or repair of engine, or whether the marks are insignificant. The following information will help to make an expert and correct decision.

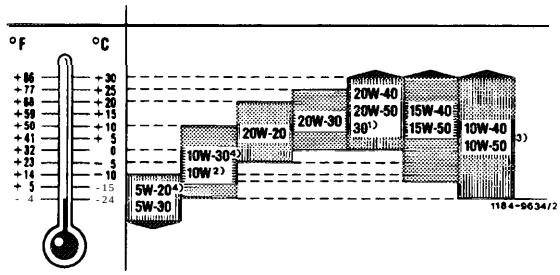


The first difference on cylinder running surfaces is between “optical streaks” and “seizure streaks”. In most cases, “optical streaks” are about 3 mm wide and are caused by ring gap, on which honing traces are still visible; with “seizure streaks”, however, the honing traces are no longer seen.

With “streaks in direction of land” (in direction of piston pin) shaft streaks or seizures are not possible, since there is no contact between piston skirt and cylinder liner.

01-030 Removal and installation of engine (oil capacity)

Specified viscosity classes according to SAE during lasting ambient temperatures



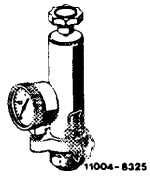
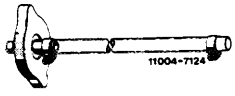
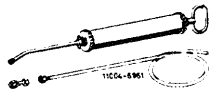
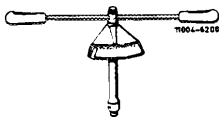
1) SAE 40 may be used during lasting outside temperatures above + 30 °C (+ 86 °F).
2) Do not use.
3) All-season oil.
4) For oils identified on sheets 226.1 and 227.1 of Specifications for service products with footnote 1), the following applies:
SAE 5 W-20 below + 10 °C
SAE 10 W-30 in temperate zones all seasons

Oil capacity in liters (for approved engine oils refer to Specifications for service products)

Engine (total filling capacity during complete refill)	7.3

Tightening torques	N m
Oil drain plug to oil pan	25
Nuts for oil filter cover	20-25
Screws for engine carrier on engine mount, front	35 + 10

Special tools

Tester for cooling system and radiator cap		001 589 48 21 00
Radiator cap with hose for leak test		605 589 00 25 00
Syringe for removing oil		112589007200
Torque wrench, double-arm, 3/8" square, 8-32 Nm		001 589 51 21 00
Torque wrench, single-arm, emitting signal with plug-in ratchet, 1/2" square, 25-130 Nm		001 589 66 21 00

Conventional tools

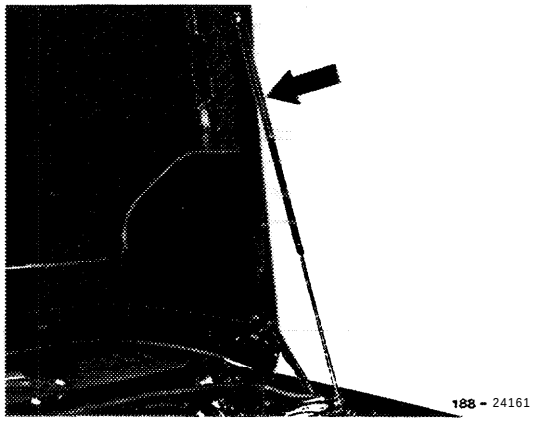
Socket wrench 7 mm on flexible shaft for hose clamps with worm drive	e.g. Hazet, D-5630 Remscheid order no. 426-7
Engine hoist no. 3180	e.g. Backer, D-5630 Remscheid, Herderstraße

Note

Remove and install engine with transmission.

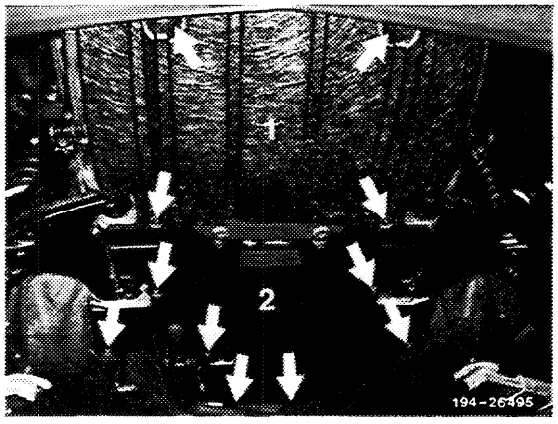
Removal

1 Put engine hood in vertical position.
For this purpose, the engine hood can be set vertically (90°) by simply pushing hood up, In vertical position, the engine hood is secured by means of a detent lever.

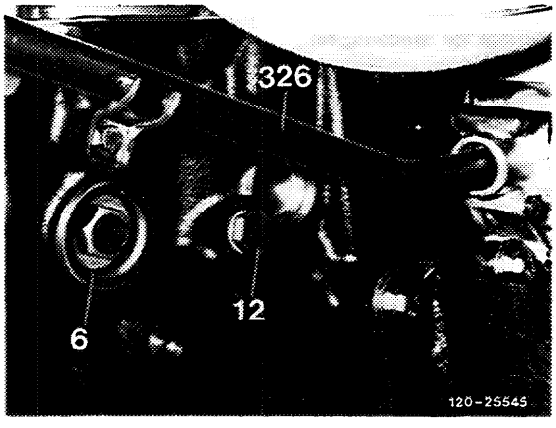


Engine hood in vertical position

2 Completely remove noise capsule below. For this purpose, unscrew sheet-metal screws (arrows).

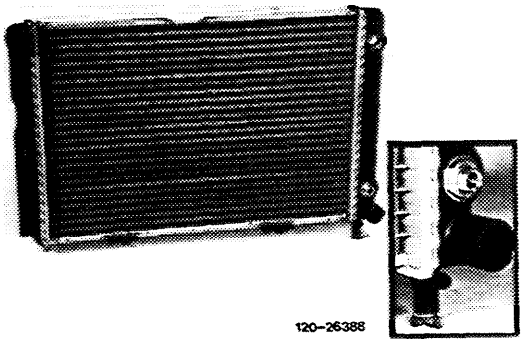


3 Completely drain coolant (20–010).



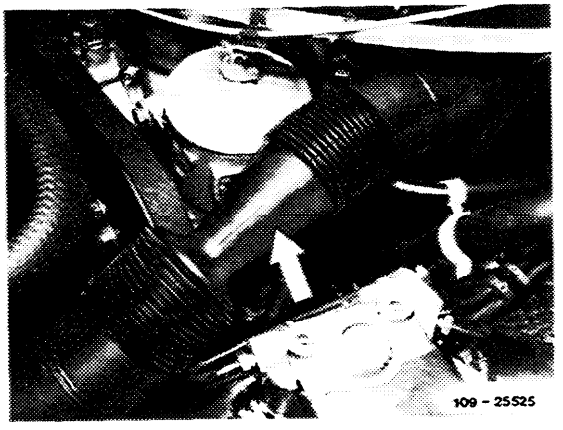
12 Drain plug of cylinder crankcase

To facilitate collection of coolant, plug an extension hose to drain connection of radiator.

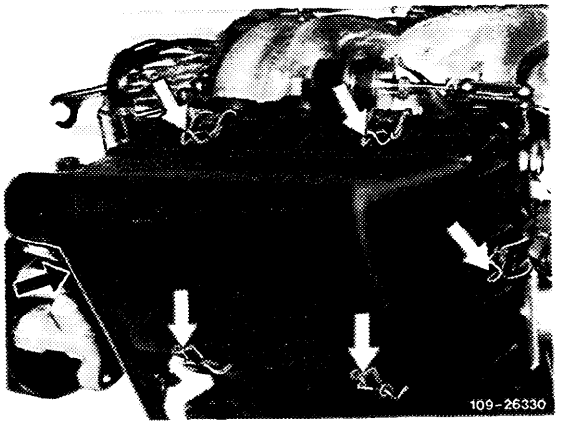


Drain plug on radiator

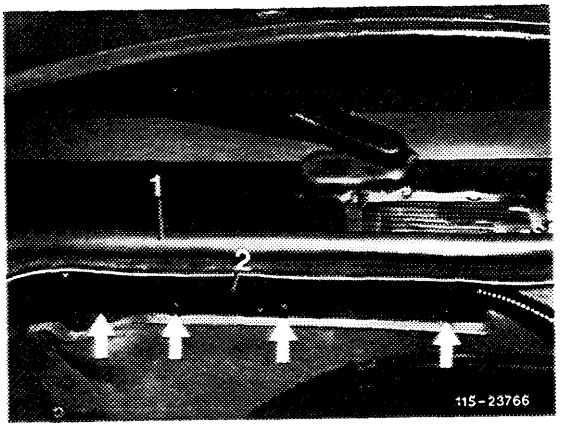
4 Remove air hose (arrow).



5 Remove air cleaner cover (arrows).

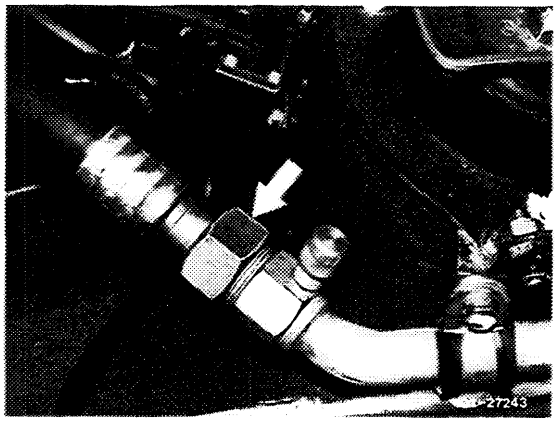


6 Disconnect battery positive line. For this purpose, pull off rubber strip (1) above bulkhead. Remove clips (arrows). Swivel holder (2) in upward direction and place battery positive cable over engine.

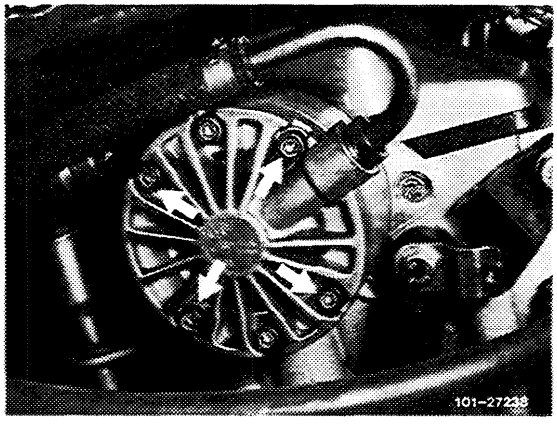


7 Remove radiator (20-420).

8 On vehicles with air-conditioning system, drain system (83–516), disconnect refrigerant hoses (arrow) and close free ends of refrigerant hoses with plastic plugs.

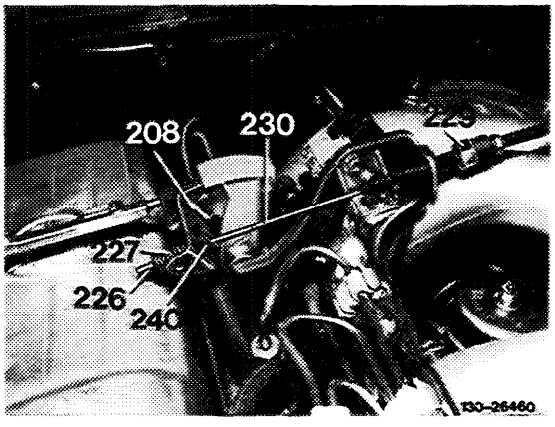


9 On vehicles with level control, unscrew hex. socket screws (arrows) and put pressure oil pump with connected lines aside. Remove driver.



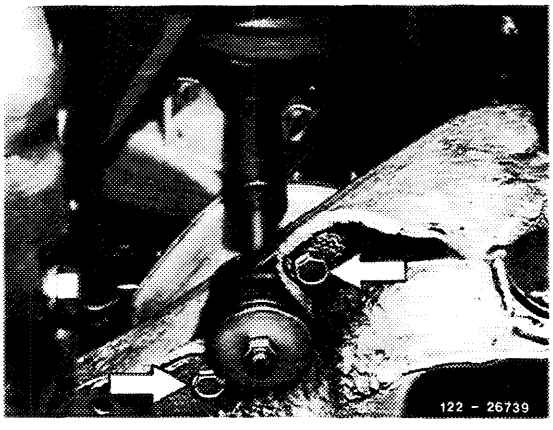
10 Draw oil from reservoir of power steering pump with syringe for oil removal and disconnect hoses.

11 Disconnect bowden wire (230) while pushing out slotted guide piece (240) on angle lever and remove bowden wire.

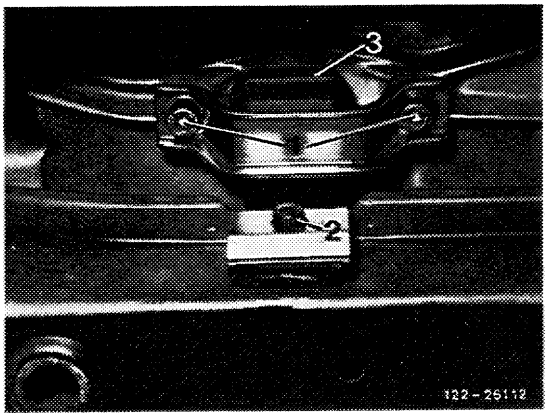


12 Disconnect all coolant, vacuum, oil, fuel and electric lines leading toward engine.

13 Unscrew engine shock absorber on cross member, while unscrewing fastening screws (arrows) for this purpose.



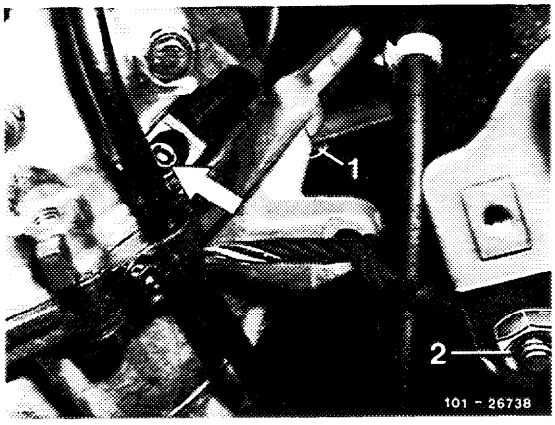
14 **Remove engine stop. For this purpose, unscrew adjusting screw (2) as well as hex. head screws (1) and remove engine stop with holder.**



15 Remove the lower of the two starter fastening screws (1) and put holder with tachometer shaft aside. Disconnect ground connecting line (2).

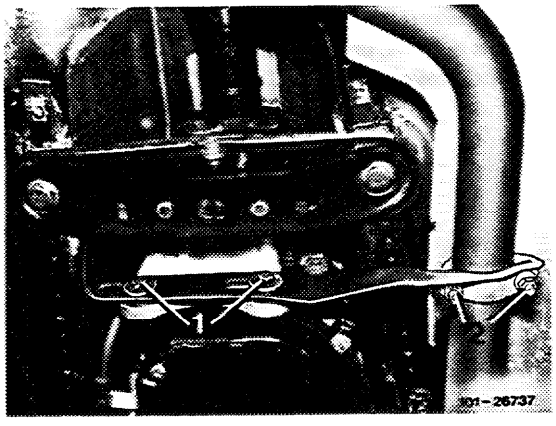
On vehicles with rpm sensor, unscrew line on oil pan (arrow).

16 Unscrew exhaust system on flange of exhaust manifold.



17 Unscrew fastening screws for exhaust lateral support (1), loosen nuts (2) and swivel holder in downward direction.

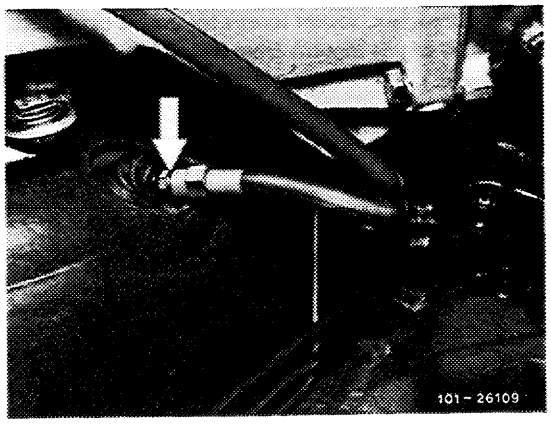
18 Unscrew propeller shaft on transmission, loosen nut of slide piece as well as fastening screws for propeller shaft intermediate bearing and slide propeller shaft back as far as possible. Also unscrew heat guide plate on vehicle floor.



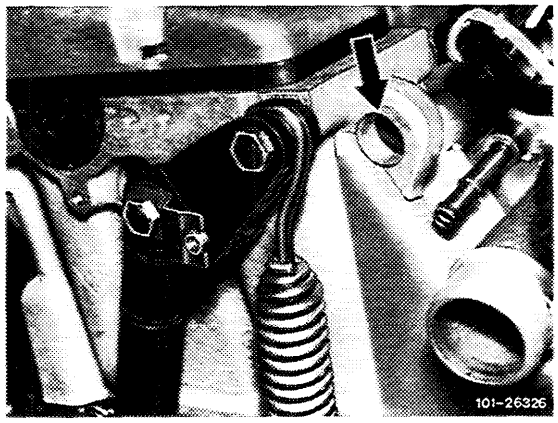
19 Unscrew drive shaft for tachometer on rear transmission cover.

20 Separate oil line from clutch master cylinder to slave cylinder (arrow).

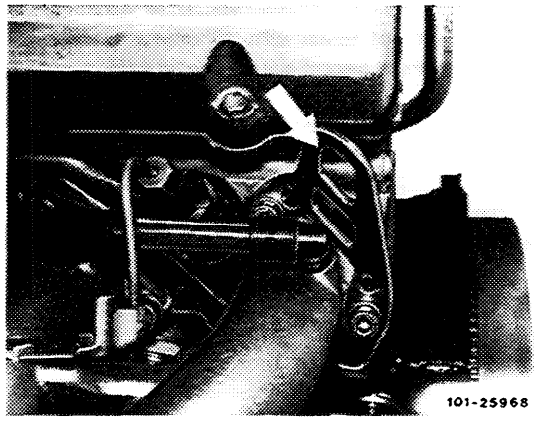
21 Remove shift rods from transmission shift levers while removing clip locks for this purpose.



22 Engage ropes of engine hoist on suspension eyes of engine (arrows). Tighten ropes.

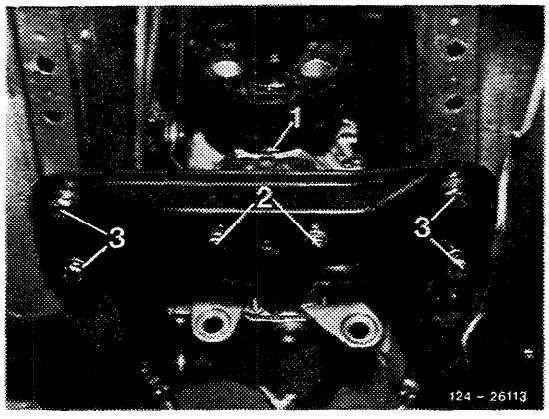


Suspension eye front



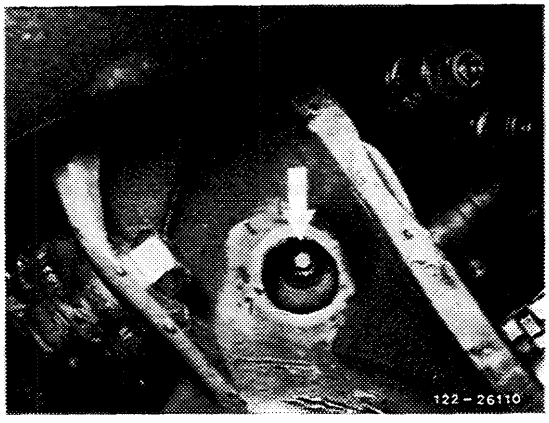
Suspension eye rear

23 Remove rear engine carrier with engine mount. For this purpose, unscrew hex. nut (1) and screw out hex. head screws (3).

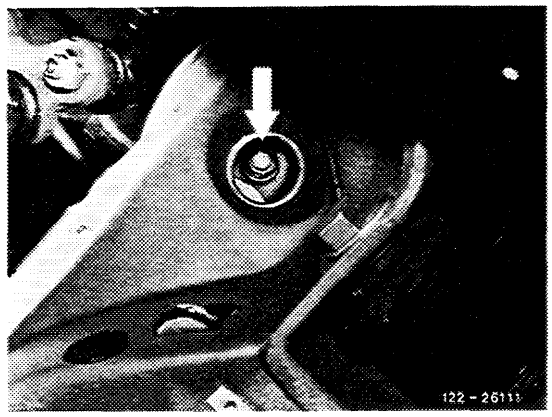


Rear engine carrier
shown on S-speed transmission

24 Unscrew hex. socket screws for engine carrier on both front engine mounts from below (arrow).



Hex. socket screw for engine carrier left



Hex. socket screw for engine mount right

25 Lift out engine with transmission in diagonal position of approx. 45".

Installation

26 Check engine mounts, engine shock absorbers, oil and fuel hoses and renew, if required.

27 Prior to flanging on manual transmission, check condition of radial ball bearing in crankshaft and of throw-out bearing of clutch; renew, if required.

28 To install engine, reverse removal procedure. Pay attention to specified torques of fastening screws and nuts.

Check installation position of shielding plates on engine mounts.

29 Screw on propeller shaft and adjust (41–020).

30 Adjust engine stop (22–220).

31 Check oil level in engine and transmission and correct, if required.

32 On vehicles with air conditioning, fill system (83–514).

33 Check all drain plugs for specified tightening torque.

34 Clean air cleaner element and renew, if required.

35 Check for leaks with engine running.

A. Standard version and (USA) Federal starting 1984

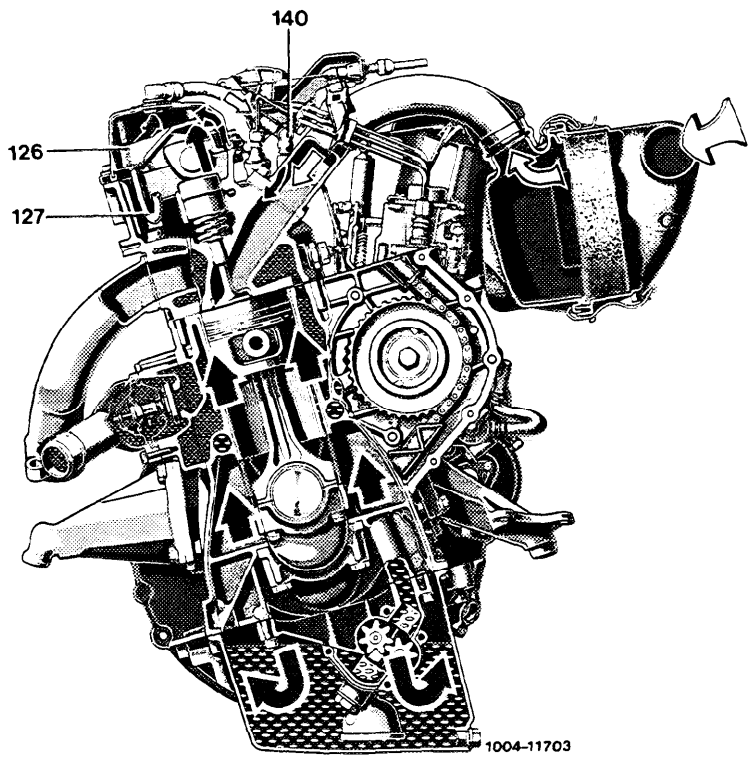
Engine601.911

The closed engine breather requires no service.

Depending on intake manifold vacuum, the engine blow-by gases are flowing through oil separator (126) in cylinder head cover and a hose line to distributing pipe (140) on intake manifold.

From here they are uniformly distributed to all the cylinders and fed to the combustion chambers together with the intake air.

The oil separated in oil separator (126) flows back to cylinder head through return pipe (127).



126 Oil separator
127 Return pipe
140 Distributing pipe
⇦ Fresh air
⇦ Blow-by gases

B. (USA) California starting 1984

Engine 601.921

Engine breather

The closed engine breather requires no service.

Operation

Depending on intake manifold vacuum, the engine blow-by gases are flowing through oil separator (126) in cylinder head cover and a hose line to distributing pipe (140) on intake manifold.

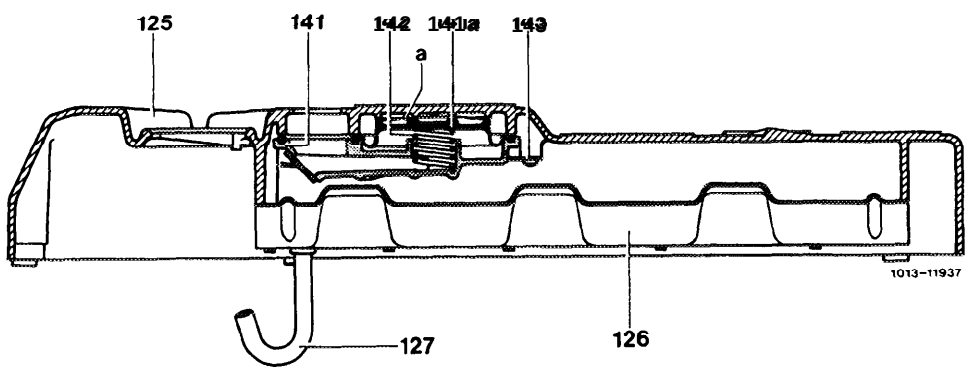
From here they are uniformly distributed to all the cylinders and fed to the combustion chambers together with the intake air.

The oil separated in oil separator (126) flows back to cylinder head through return pipe (127).

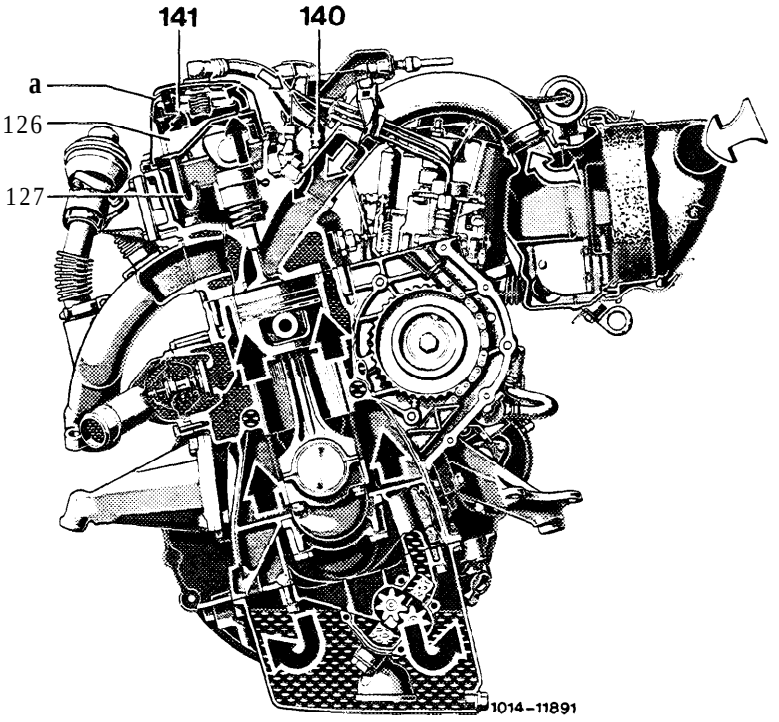
Since on engine in California version the vacuums are considerably higher under influence of throttle valve in intake system, the oil separator (126) is provided with a pressure control valve (141, diagram valve).

The valve prevents an excessive vacuum in cylinder crankcase and the resultant loss of oil (suction).

To vent diaphragm chamber in pressure control valve, the cylinder head cover is provided with a bore (a). Make sure that this bore is not closed or will not be closed by dirt or preservation compound.



125 Cylinder head cover
126 Oil separator
127 Return pipe
141 Diaphragm housing (pressure control valve)
141a Diaphragm
142 Spring
143 Holder
a Vent bore



126 Oil separator
127 Return pipe
140 Distributing pipe
141 Pressure control valve
a Bore 3 mm dia.

⇦ Fresh air
⇦ Blow-by gases

01-I 10 Measuring cylinder bores

Data

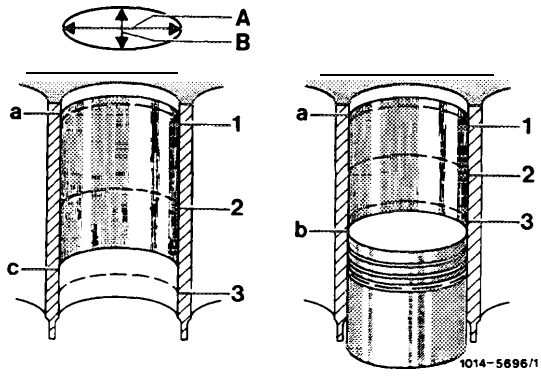
Engine[1]			601	
Version		Group Code letter	Piston dia.	Cylinder dia.
Std (standard)	Cylinder 1-4	A	86.970-86.976	87 .OOO-87.006
		X	above 86.975-86.983	above 87.006-87.012
		8	above 86.982-86.988	above 87.012–87.018
Max. wear limit in driving or transverse direction				0.10
Permissible out-of-round and conicity			when new	0.014
			wear limit	0.05
Permissible deviation, vertically in relation to crankshaft axis, with reference to cylinder height				0.05
Permissible roughness (ℜ 3 Z)				0.003-0.006
Permissible waviness				50 % of roughness

[1]) There are no repair stages for these engines.

Measu ri ng

Measure the cleaned cylinder bores with an internal measuring instrument at measuring points 1, 2 and 3 in longitudinal direction A (piston pin axis) and in transverse direction 8.

With piston installed the measuring point 3 is barely above piston, which should be at BDC.



A Longitudinal direction
B Transverse direction
a Upper reversing point of 1st piston ring
b BDC of piston
c Lower reversing point of oil scraper ring

01-I 15 Renewing, boring and honing cylinder liners

Data

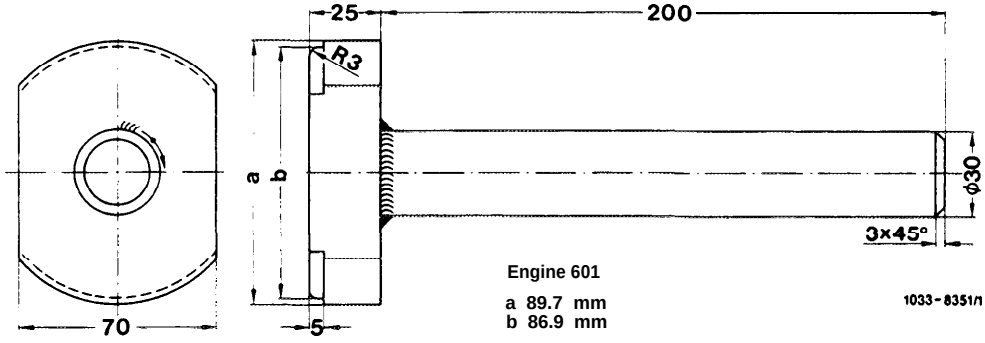
Engine[1]			601	
Version		Group Code letter	Piston dia.	Cylinder dia.
Std (standard)	Cylinder I - 4	A	86.980-86.976	87.000-87.006
		X	above 86.975-86.983	above 87.006-87.012
		B	above 86.982-86.988	above 87.012-87.018

Basic bore in cylinder crankcase for cylinder liner	90.000 90.035
Permissible out-of-round of basic bore in cylinder crankcase	0.01
Permissible out-of-round and conicity of cylinder bore	0.01
Permissible roughness of cylinder bore (R 3 Z)	0.003-0.006
Permissible waviness of cylinder bore	50 % of roughness
Honing angle	25”
Roughness of cylinder crankcase parting surface	0.006-0.016
Chamfer of cylinder bores	refer to Fig.

[1]) There are no repair stages for these engines,

Self-made tool

Mandrel for pressing out or knocking out cylinder liners



Note

Only approved cylinder liners may be installed on principle (refer to replacement parts data).

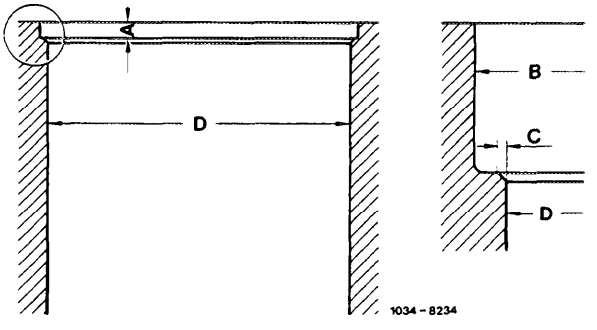
Renewing

1 Press out cylinder liners with self-made mandrel and a press or knock out with a hammer.

2 Thoroughly clean basic bore.

3 Measure basic bore (D) in cylinder crankcase.

When boundary dimensions (refer to Table) are exceeded, do no longer use cylinder crankcase.



A 4.3-4.6 mm
B 92.65-92.75 mm
C 0.25-0.35 mm
D 90.00-90.035 mm

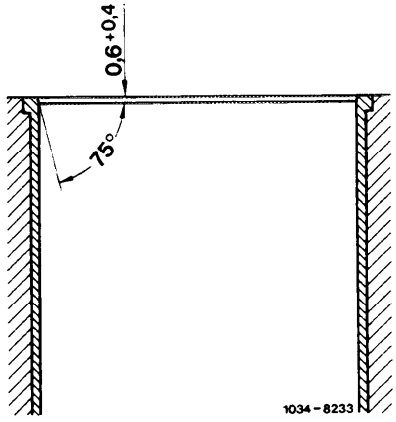
4 Position new cylinder liners. Place a steel plate of pertinent size on liner flange and press in bushing by means of a press or knock in by meanf of a hammer.

After pressing or knocking in, leave cylinder liner for an additional 7 seconds under press pressure (settling pressure) or apply a few settling blows with hammer.

5 Mill off or grind off the projecting flange of bushing. Remove as little as possible from cylinder crankcase parting surface. Guide milling cutter or grinding wheel centrally over cylinder bores.

6 Enlarge (bore) cylinder liners in two steps. For honing, leave an allowance of 0.03 mm in bores.

7 Chamfer cylinder liners.



8 Hone cylinder bores.

9 Measure cylinder bores and select matching pistons (01-I 10).

01-120 Facing cylinder crankcase parting surface

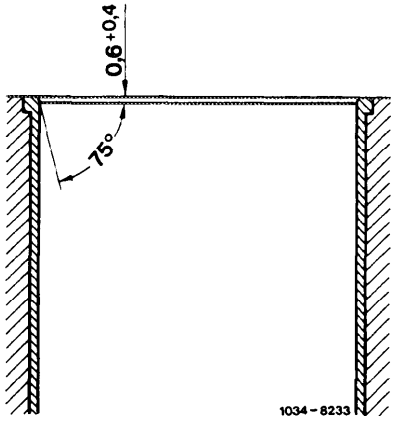
Data		
Height of cylinder crankcase when new		300-299.95
Minimum height following a required material removal		
Permissible unevenness of parting surface	in longitudinal direction	0.10
	in transverse direction	0.05
Permissible roughness of upper parting surface		0.006-0.016
Permissible deviation from parallel between upper and lower crankcase parting surface in longitudinal direction		0.1
Pressing off pressure with air under water in bar gauge pressure		1.5
Chamfer of cylinder bores		refer to Note
Distance between piston crown and cylinder crankcase parting surface	engine 601.911	+ 0.65 to + 1.05
	engine 601.921	+ 0.50 to + 0.90

Note

Prior to facing, check piston standout (projection). Do not exceed piston standout of 0.9 or 1.05 mm (03–316).

Chamfer cylinder bores after facing.

Check timing, if cylinder crankcase parting surface has been refinished (05–215).



01-130 Knocking out and inserting steel balls in main oil duct

Special tool

Knocking-in mandrel for steel ball	11004-11746	601 589 08 15 00

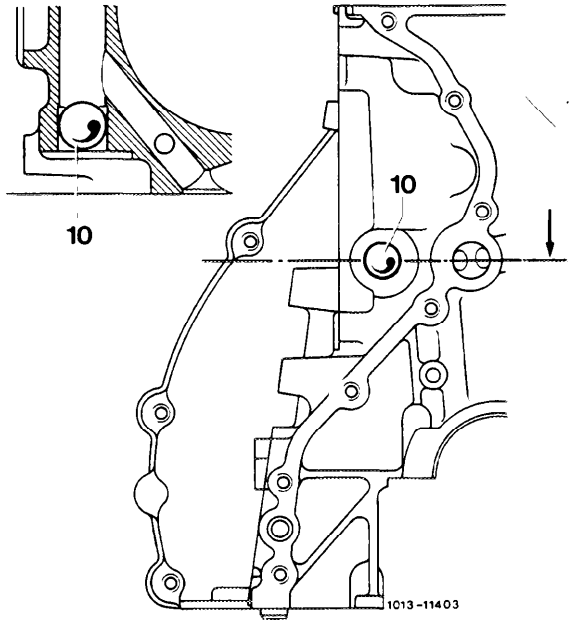
Note

The main oil duct is closed with steel balls, 17 mm dia. at the front, 15 mm dia. at the rear.

When reconditioning engine, the steel balls must be knocked out from the rear for cleaning main oil ducts.

Undamaged steel balls can be used several times without refinishing of ball seat.

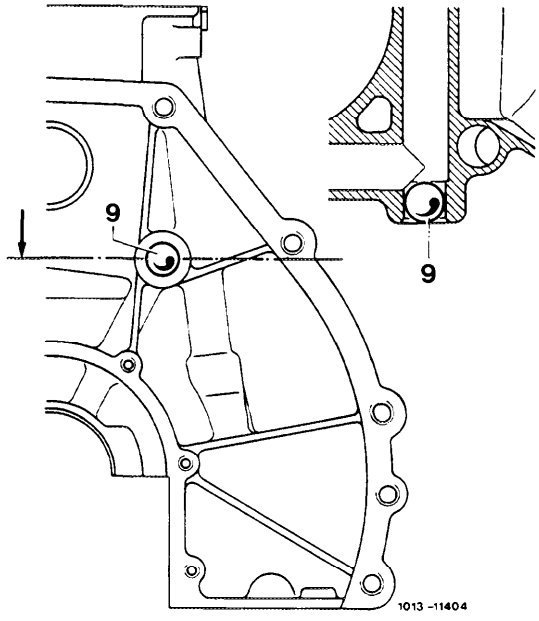
Renew damaged steel balls.



10 Steel ball, front

In the event of leaks, reseat steel balls in cylinder crankcase with a knocking-in mandrel for approx. 1 mm (dimension is indicated on knocking-in mandrel).

If the leaks are still not yet repaired, knock out both steel balls and close the respective main oil duct end with closing plug (front) M 18 x 1.5, part no. 000906 018000 or (rear) M 16 x 1.5, part no. 000906 0 16002.



9 Steel bail, rear

For this purpose, cut threads M 18 x 1.5, 10 mm deep, at main duct front. Thoroughly remove chips from oil ducts.

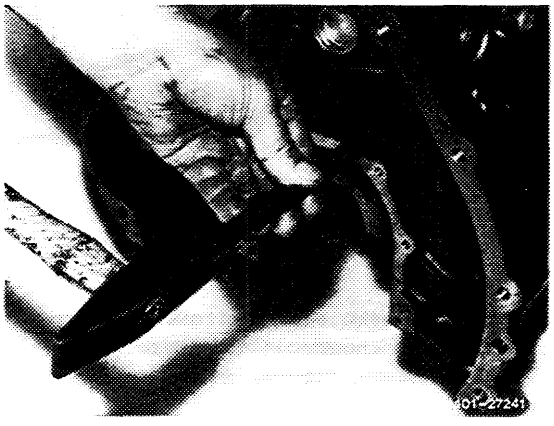
Coat closing plug M 18 x 1.5 with sealing glue Loctite 241, part no. 002 989 94 71 and screw in.

Cut threads M 16 x 1.5 mm approx. 14 mm deep into main oil duct on main oil duct rear.

Thoroughly remove chips from oil duct.

Coat closing plug M 16 x 1.5 with sealing glue Loctite 241, part no. 002 989 94 71 and screw in.

Main oil duct front and rear



Knocking out

1 Remove coolant pump with housing (20–230).

2 Remove transmission and flywheel (03-410).

3 Knock out both steel balls from the rear to the front by means of a round steel bar (approx. 14 mm and approx. 550 mm long).

Knocking in

4 Thoroughly clean bore in pressing in range of steel ball.

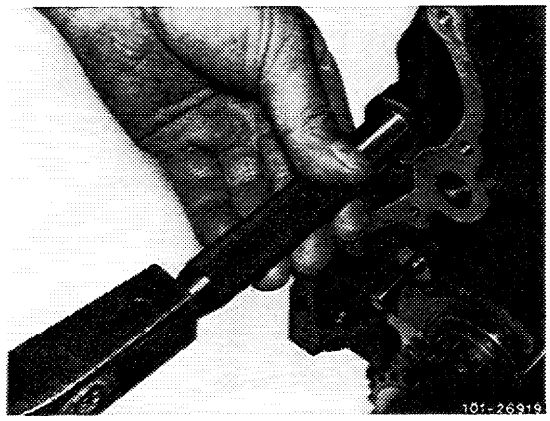
5 Coat spherical indentation on knocking-in mandrel with grease and place steel ball into indentation.

103-13405

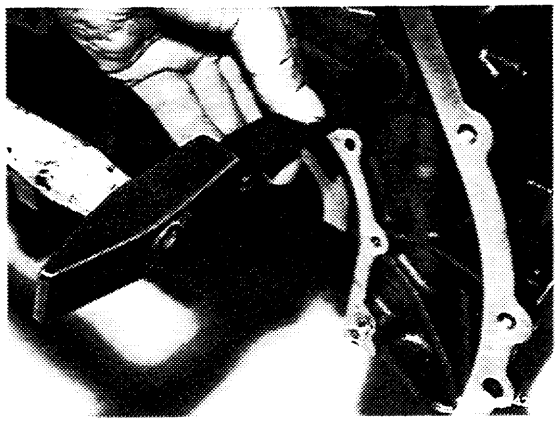
6 Position steel balls and knock in up to stop on mandrel.

7 Mount all removed or disassembled parts.

8 Run engine warm and check for leaks.



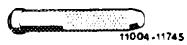
Knocking in steel ball, front



Knocking in steel bail, rear

01-140 Replacing core hole cover in cylinder crankcase

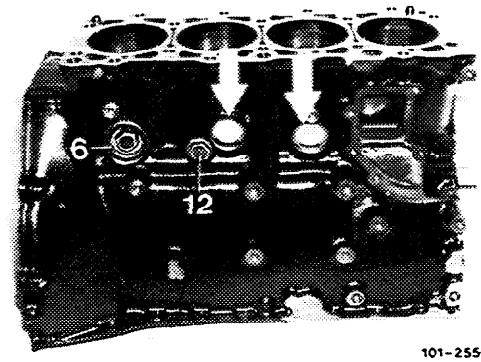
Special tools

Knocking-in mandrel for cover, 17 mm dia.	 11004-11745	601 589 07 15 00
Knocking-in mandrel for cover, 34 mm dia.	11004-9625	102589001500

Note

The core holes in cylinder crankcase are closed with sheet metal covers (17 mm dia. or 34 mm dia.).

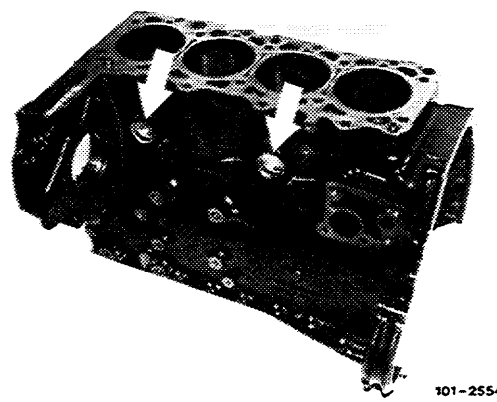
Be sure to replace leaking covers on principle.



Cylinder crankcase
Driving direction, right

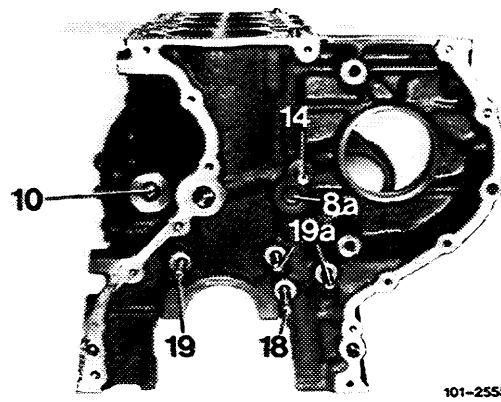
101-25547

At the right (driving direction) a closing plug (6, M 38 x 1.5) is retained. A coolant preheater can be placed into this core hole.



Cylinder crankcase
Driving direction, left

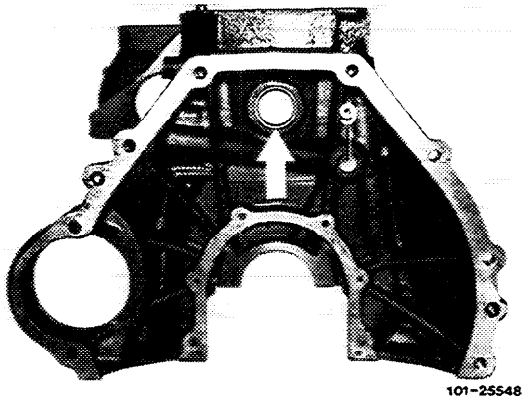
101-25546



Cylinder crankcase
Face, front

8a Core hole cover, front

101-25550

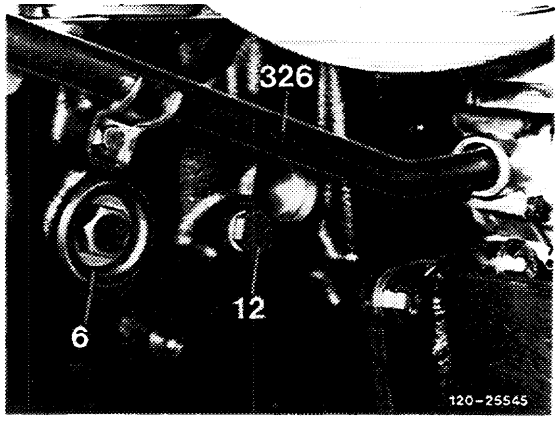


Cylinder crankcase
Transmission side
Arrow = core hole cover, rear

Renewing

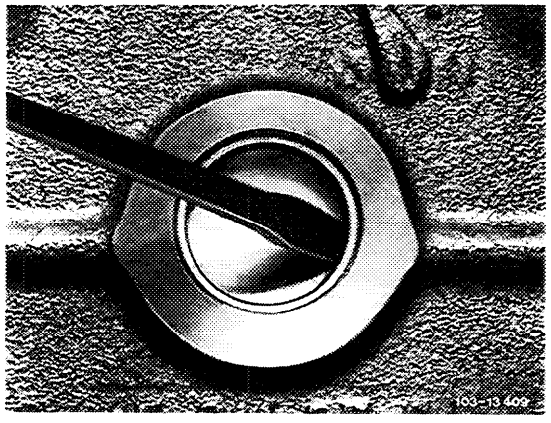
1 Completely drain coolant (20-010).

2 Remove unit parts which prevent access (e.g. transmission, injection pump, etc.).

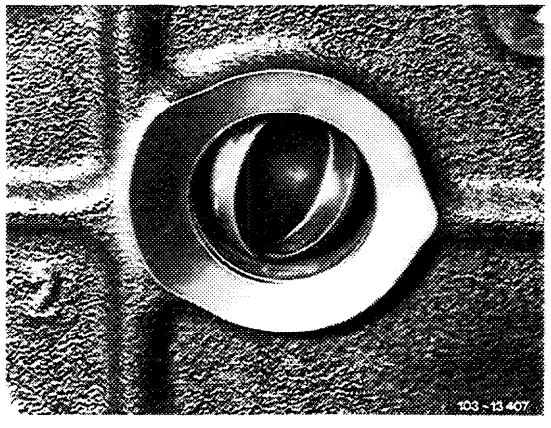


6 Closing plug
12 Drain plug on crankcase

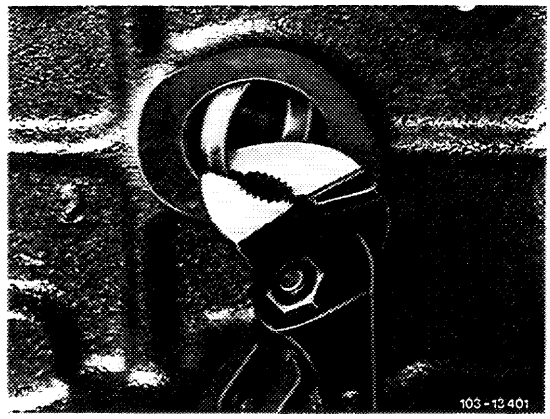
3 Position a chisel with narrow blade or a screwdriver in deep-drawn edge of closing cover.



4 Carefully knock in cover on one side until it has turned around its own longitudinal axis (approx. 90").

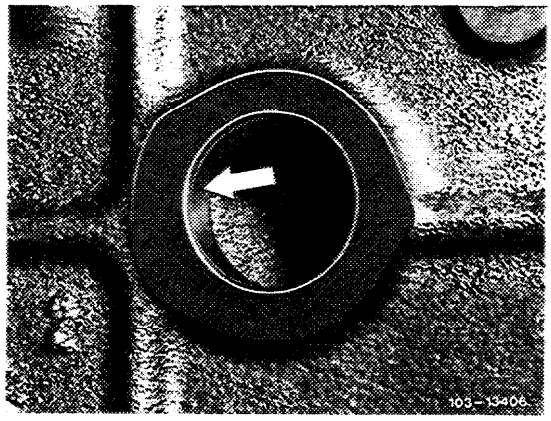


5 Position water pump pliers at flange of projecting part and pull out cover.



6 Thoroughly clean core hole from residue. Sealing surface must be free of grease (arrow).

7 Coat core hole with sealing glue Loctite 241, part no. 002 989 94 71.

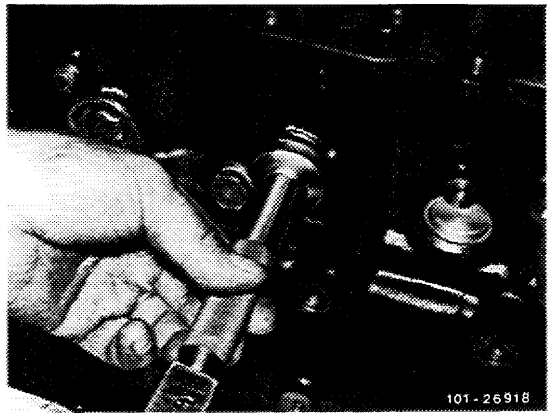


8 Knock in new closing cover by means of pertinent knocking-in mandrel.

9 Attach removed unit parts.

10 Fill in coolant (20–010).

Note: The sealing glue should cure approx. 45 minutes before filling in coolant.

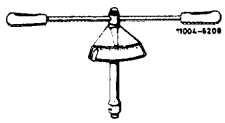
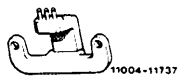


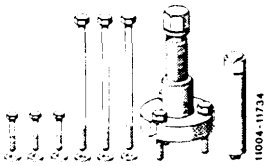
11 Run engine warm and check for leaks.

01-210 Removal and installation of timing housing cover

Tightening torques		Nm
Hex. head screw to crankshaft front		370 + 40
Screws M 8 x 12 for pulley to hub		25
Oil drain plug to oil pan		25
Oil pan to cylinder crankcase	M 6	10
	M 8	25
Central screw for fan to coolant pump		25
Adjusting screw for front engine stop		130
Engine carrier to engine mount front		35 + 10
Screws for cylinder head cover		10
Cylinder head screws M 8 (reference value)		25
Screws for timing housing cover	M 6	10
	M 8	25

Special tools

Torque wrench, double-arm, 3/8" square, 8-32 Nm		001 589 51 21 00
Torque wrench, single-arm, emitting signal with plug-in ratchet 1/2" square, 40-200 Nm		001 589 67 21 00
Torque wrench single-arm, with ratchet, 3/4" square, 150–800 Nm		001 589 74 21 00
Detent		601 589 02 40 00
Screwdriver with tommy handle for hex. socket screws 6 mm, 440 mm long		116589030700
Sleeve for pushing in radial sealing ring, front		601 589 03 14 00

Puller for flange on crankshaft		601 589 08 33 00
Box end-Allen wrench 13 x 14 mm		117589020700

Conventional tools

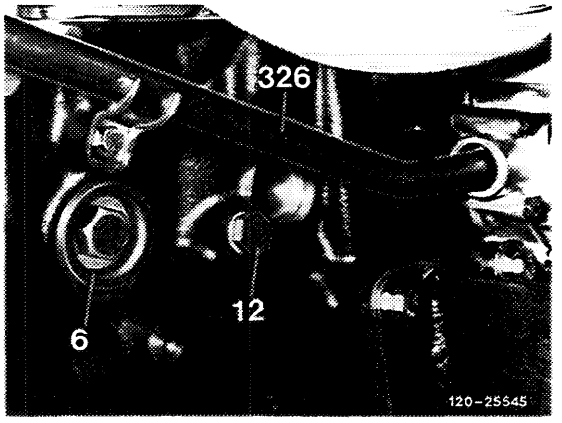
Connection 3/4'' square socket to 1/2'' square head	e.g. Hazet, D-5630 Remscheid order no. 1058 R. 1
Engine hoist no. 3180	e.g. Backer, D-5630 Remscheid, Herderstraße
Socket wrench 7 mm on flexible shaft for hose clamps with worm drive	e.g. Hazet, D-5630 Remscheid order no. 426-7

Removal

1 Completely remove noise capsule.

2 Drain engine oil.

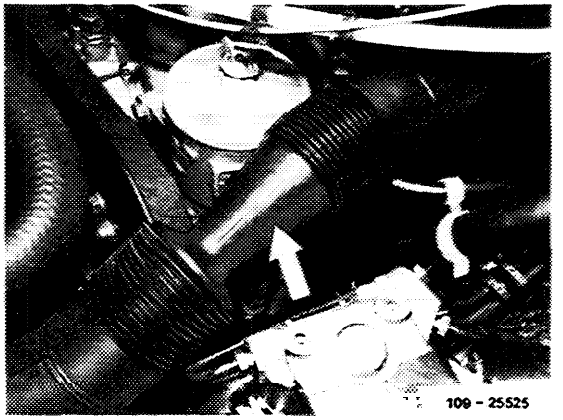
3 Completely drain coolant (20–010).



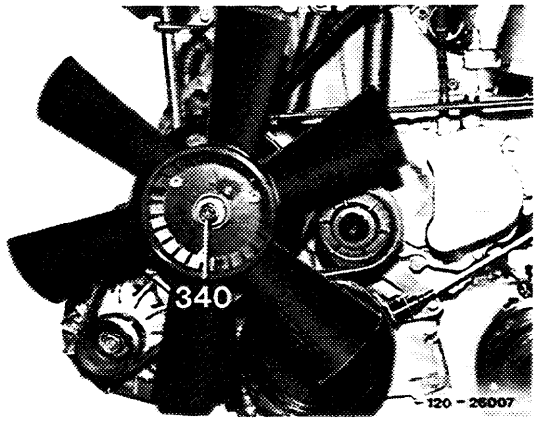
4 Remove air hose (arrow).

5 Remove radiator (20-420).

6 Disconnect negative terminal on battery.

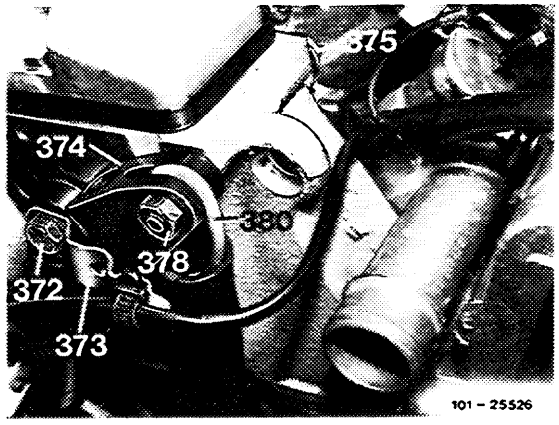


7 Unscrew collar screw (340) and remove fan.

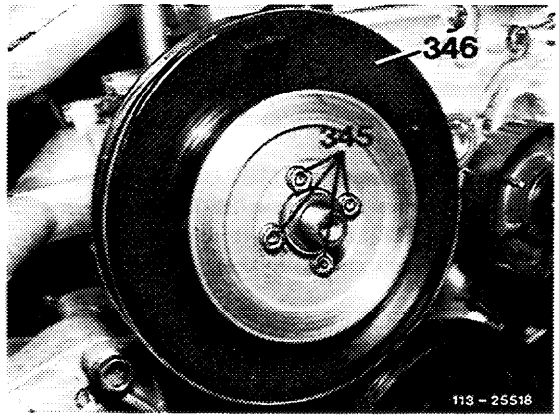


8 Slacken V-belt and remove. For this purpose, unscrew flange nut (378). Insert a mandrel into spring tensioning lever (374) and releave hex. screw (375) against draw spring (380) until spring can be pushed back in direction of intake manifold.

Release spring tensioning lever and remove V-belt.



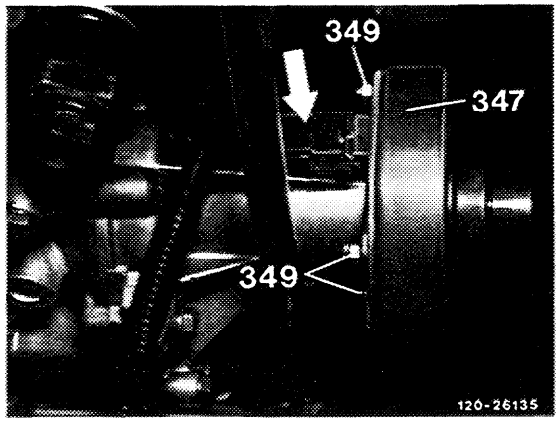
9 Unscrew hex. socket screws (345) of coolant pump pulley and **remove pulley** (346).

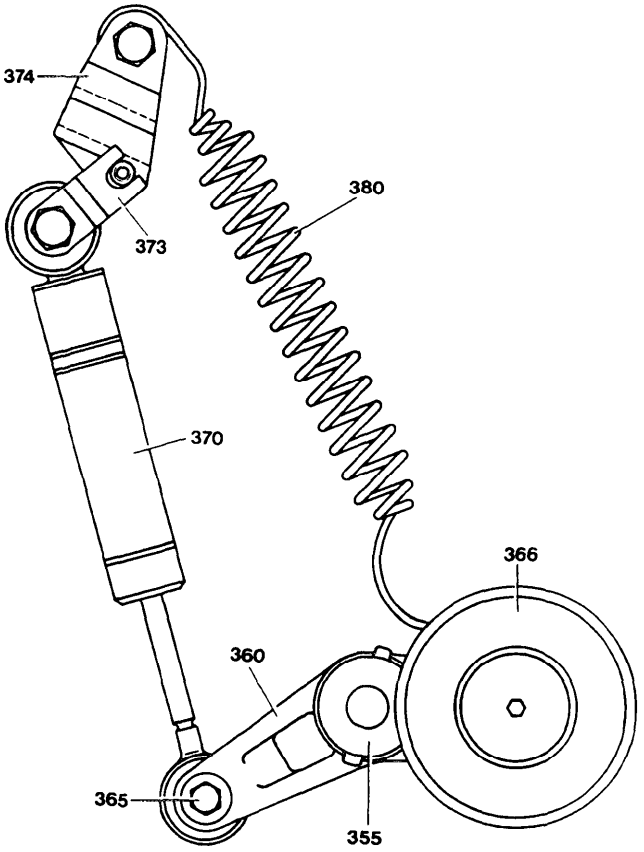


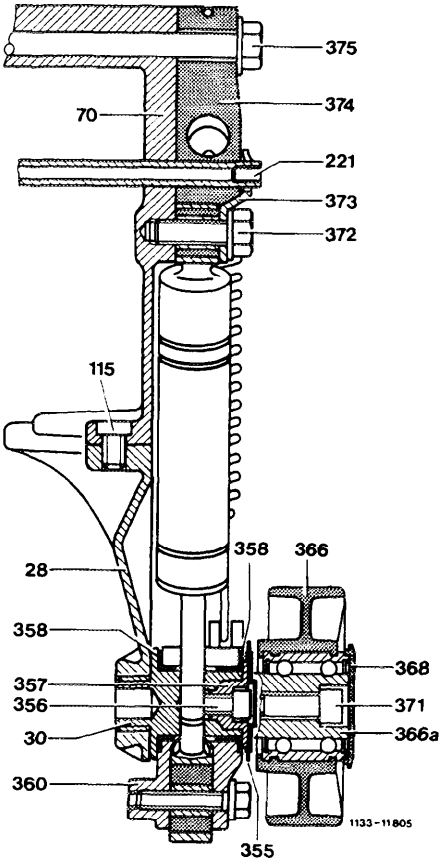
10 Pull cable from magnetic body (arrow).

11 Unscrew magnetic body (347) from magnet carrier on fastening nuts (349).

Note: The magnet carrier is glued to coolant pump housing and should not be pulled off.







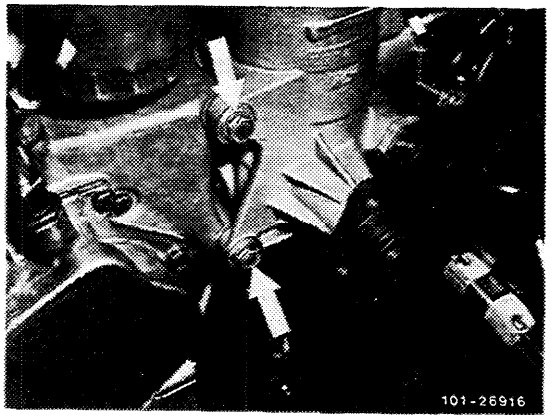
355 Closing cover M 6 x 25
356 Hex. socket screw
357 Lock washer
360 Tensioning lever
372 Hex. screw M 8 x 30
373 Holder

12 Completely remove V-belt tensioning device. Unscrew hex. screw (372) for this purpose.

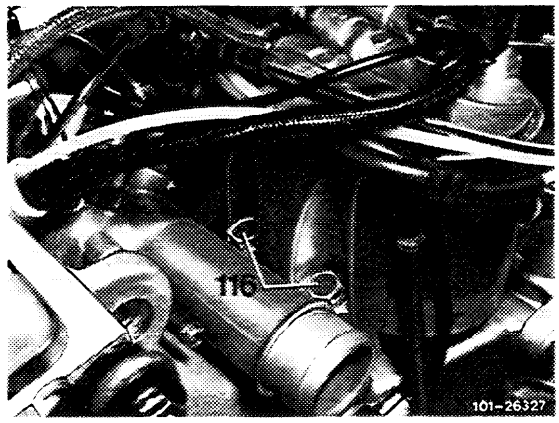
13 Remove closing cover (355). Unscrew screw **(356)** and remove lock washer (357). Remove tensioning lever **(360)** together with shock absorber and draw spring from bearing bolt.

14 On vehicles with power steering, unscrew pulley for high pressure pump.

15 Unscrew both hex. screws for high pressure oil pump fastening (arrows) and put high pressure oil pumps with lines connected aside.

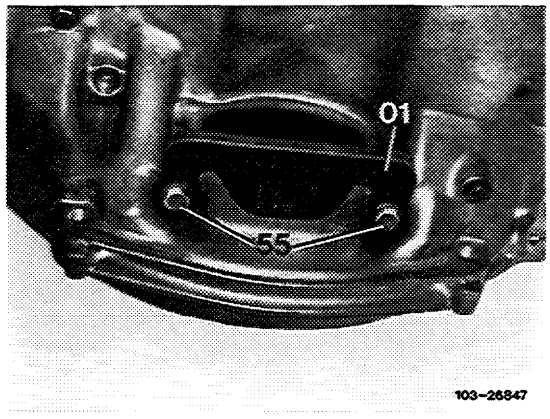


16 Unscrew the front screw of the two screws for fastening fuel filter (116).



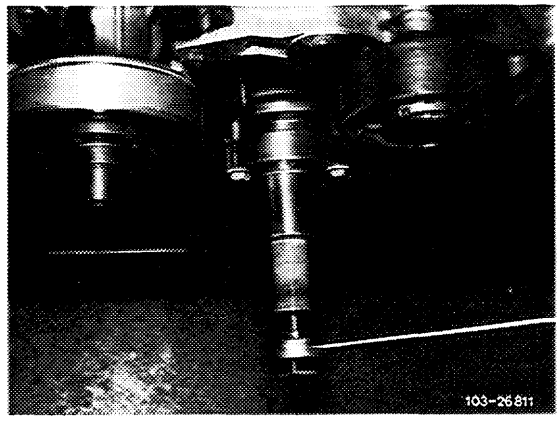
17 Unscrew crankshaft pulley.

18 Unscrew hex. screw for flange. For this purpose, mount detent, part no. 601 589 02 40 00, to oil pan.

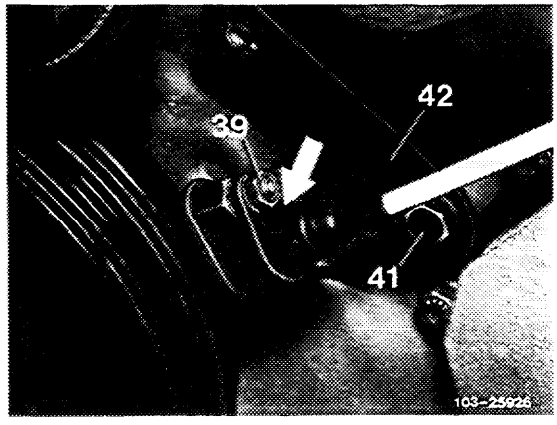


19 Pull off crankshaft flange manually.

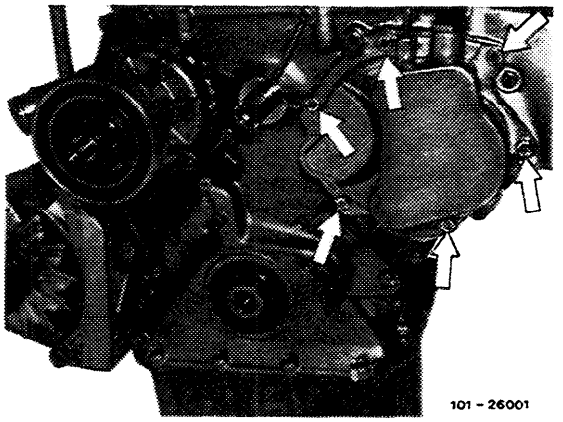
If hard to move, pull off crankshaft flange with puller, part no. 601 589 08 33.



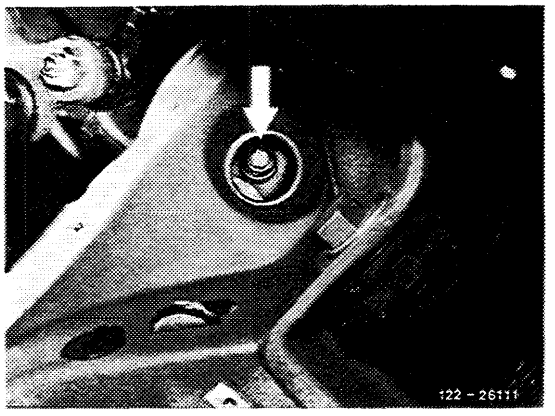
20 On vehicles with TDC transmitter, unscrew hex. nut (39), pull TDC transmitter line out of holder (42) and put aside.



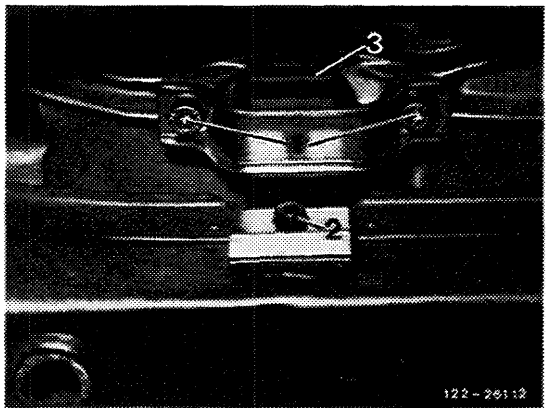
21 Unscrew vacuum pump (arrows).



22 Unscrew both fastening screws for engine carrier on engine mount (arrow).



23 Unscrew engine stop on frame cross member. For this purpose, unscrew adjusting screw (2) as well as hex. screws (1).

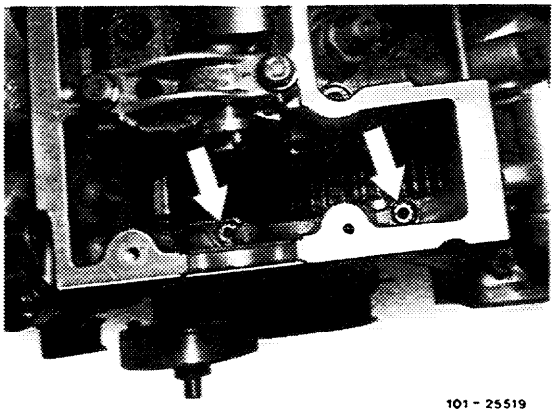


24 Attach rope of engine hoist at front suspension eye (arrow) and lift engine with a crane.

25 Unscrew fastening screws for oil pan front in range of timing housing cover. Loosen all remaining fastening screws.

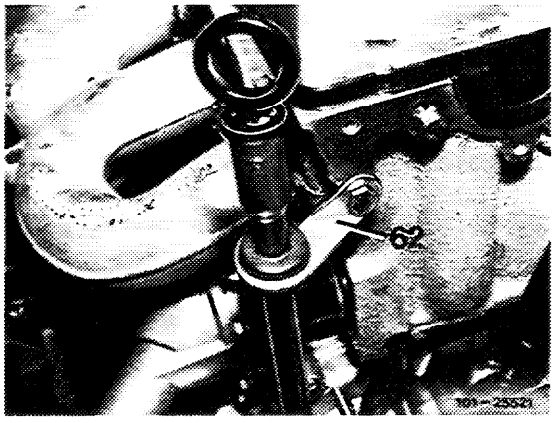
26 Lower engine again into engine mounts.

27 Remove cylinder head cover.

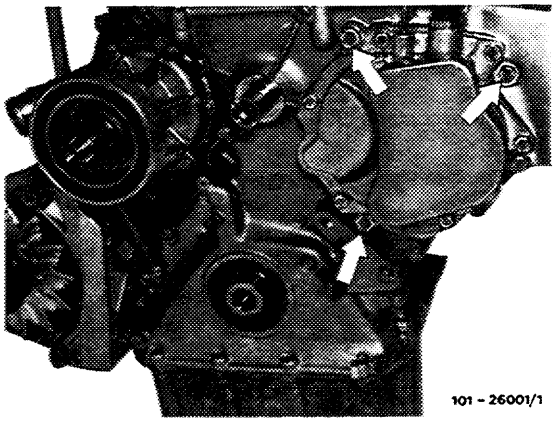


28 Unscrew the two cylinder head screws M 8 (arrows) in chain box with Allen wrench 6 mm, 440 mm long.

29 Unscrew holder for oil dipstick guide tube (62).



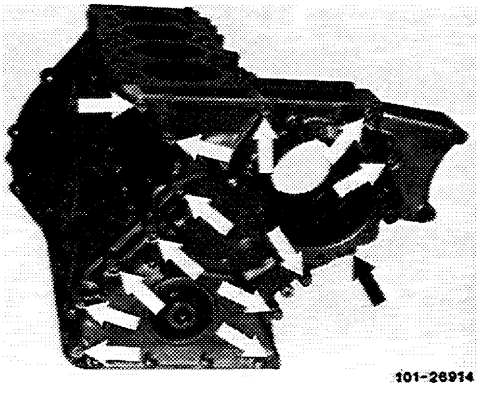
30 Unscrew fastening screws (arrows) for injection pump. Remove square nuts on flange of injection pump.



31 Unscrew remaining fastening screws for timing housing cover (arrows).

32 Remove timing housing cover.

Attention!
Do not damage cylinder head gasket. Renew damaged cylinder head gasket.



33 Clean parting surfaces.

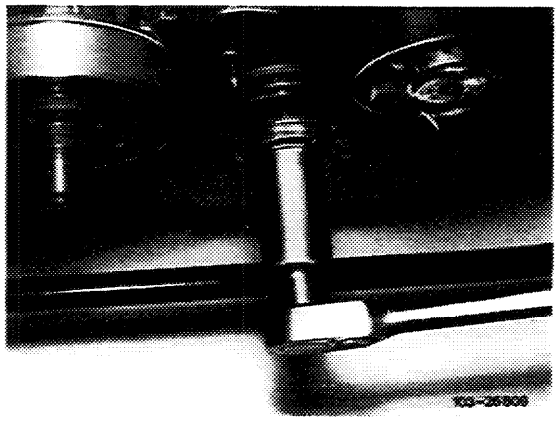
34 Coat timing housing cover parting surface with sealing compound "Curil T", part no. 001 98947 20.

35 Carefully position timing housing cover, while paying attention to cylinder head gasket,

36 Screw on timing housing cover. Pay attention to different screw lengths.

37 If the radial sealing ring has been removed, insert new radial sealing ring with sleeve, part no. 601 589 03 14 00.

38 For further installation proceed vice versa.



39 Adjust engine stop (22–220).

40 Check and correct oil level in engine.

41 Fill in coolant (20-010).

42 Pressure-test cooling system with tester.

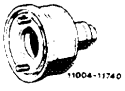
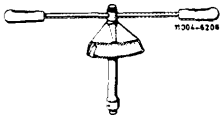
43 Run engine, check for leaks,

01–222 Removal and installation of end cover

Tightening torques

Fastening screws for end cover		10 Nm
Necked-down screws for flywheel and driven plate	initial torque	30 + 10 Nm
	angle of rotation torque	90-100”

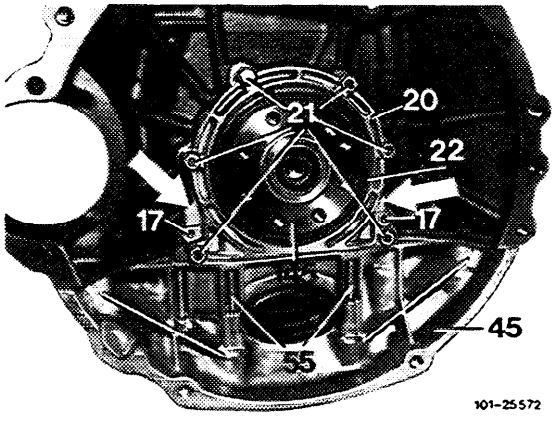
Special tools

Installation tool for rear crankshaft radial sealing ring and end cover		601 589 03 43 00
Torque wrench, double-arm, 3/8” square, 8-32 Nm		001 589 51 21 00
Torque wrench, single-arm, emitting signal, with plug-in ratchet, 1/2” square, 25-130 Nm		001 589 66 21 00

Note

The central installation position for crankshaft center is located by means of two clamping sleeves (17).

The end cover is sealed in relation to cylinder crankcase with sealing compound Loctite 573, part no. 001 989 45 20.



17 Clamping sleeve
20 End cover
21 Combination screw (M 6 x 22)
22 Radial sealing ring
55 Combination screw (M 6 x 85)
145 Crankshaft

Removal

1 Remove transmission (26-020 or 27–600).

2 Remove flywheel or driven plate (03-410).

3 Unscrew fastening screws (21 and 55) and force off end cover on both lugs (arrows).

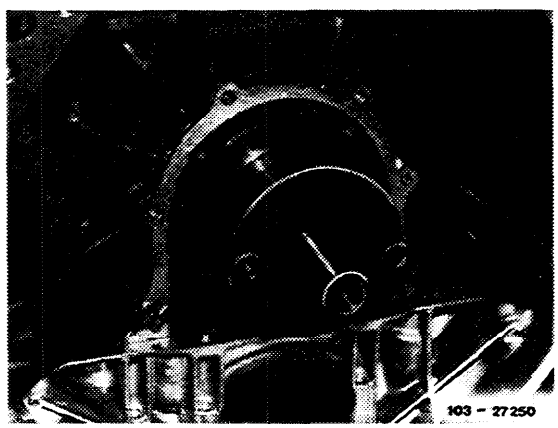
4 Clean sealing surfaces on cylinder crankcase and end cover.

5 Check whether radial sealing ring is damaged. Renew radial sealing ring.

Installation

6 Coat end cover on sealing surface uniformly with sealing compound "Loctite 573", part no. 001 989 45 20.

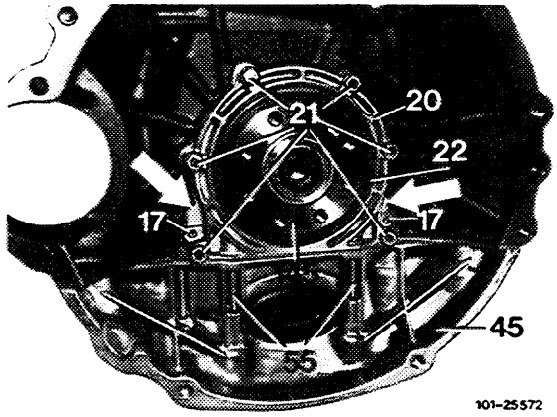
7 Slip end cover with pressed in radial sealing ring over screwed on assembly sleeve. Pay attention to oil pan gasket.



8 Tighten fastening screws (21 and 55) to 10 Nm.

Tighten fastening screws (55) first.

9 Run engine warm and check for leaks.



01-310 Removal and installation of oil pan

Oil capacity in liters	
Oil pan	5
Oil filter	1.5

Tightening torques		Nm
Oil drain plug to oil pan		25
Oil pan to cylinder crankcase	M 6	10
	M 8	25
Adjusting screw for front engine stop		130
Adjusting screw for rear engine mount		30
Engine carrier to engine mount front		35 + 10

Special tools

Torque wrench with plug-in ratchet, 1/2'' square, 25-l 30 Nm		001 589 66 21 00
Torque wrench with plug-in ratchet, 1/2'' square, 40-200 Nm		001 5896721 00
Screwdriver with tommy handle for hex. socket screws 5 mm, 300 mm long		116589020700
Screwdriver with tommy handle for hex. socket screws 6 mm, 440 mm long		116589030700
Box end-Allen wrench 13 x 14 mm		117589020700

Conventional tool

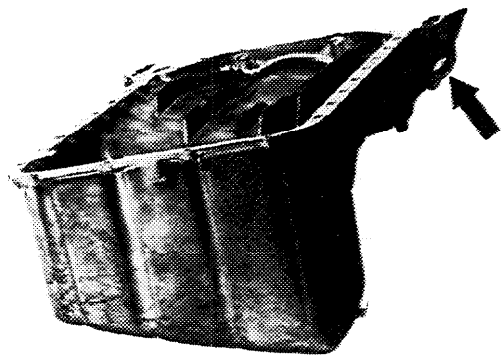
Engine hoist no. 3180	e.g. Backer, D-5630 Remscheid, Herderstraße

Note

The engines are provided with a light alloy oil pan. The pan is sealed in relation to cylinder crankcase by means of a gasket.

At the rear left (arrow) is the rpm sensor for refrigerant compressor shutoff, EG R (California version) and revolution counter.

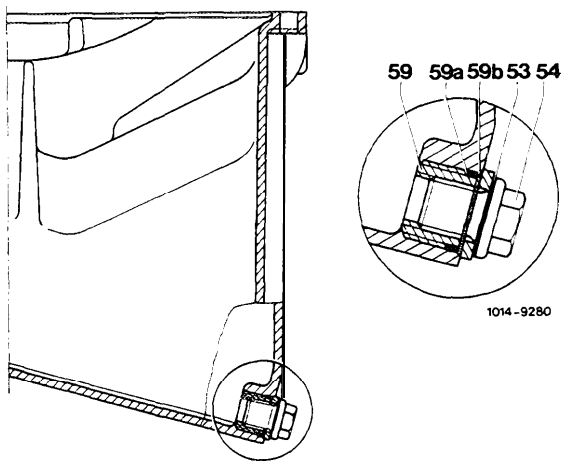
To make sure that the oil pan floor in range of oil pump strainer is horizontal with engine installed (engine installation position tilted 15" to the right), the oil pan floor has also a tilt of 15° in relation to cylinder crankcase parting surface.



101-26985

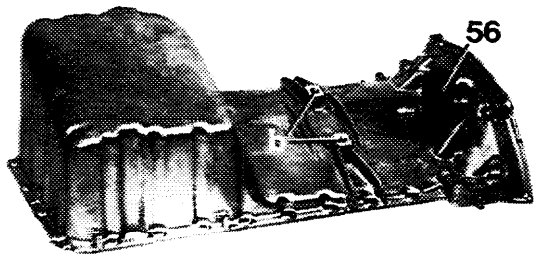
The oil drain plug (54, M 12 x 1.5) is attached at front left.

The threaded bushing is sealed by an O-ring (59a) and is locked against rotation by means of a toothed collar (59b), which digs into oil pan when inserted.



1014-9280

53 Sealing ring
54 Oil drain plug M 12 x 1.5
59 Threaded bushing
59a O-ring
59b Toothed collar



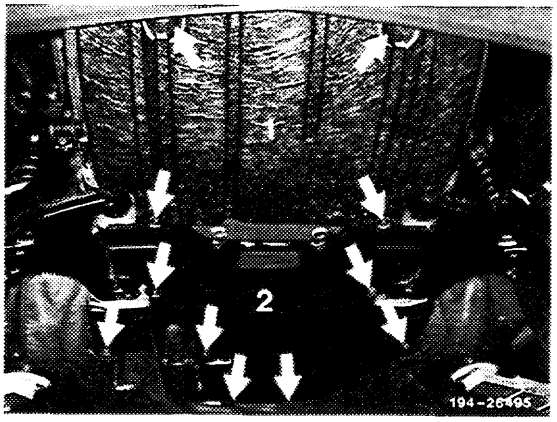
56 Closing cover
b Fastening points for engine stop

101-26986

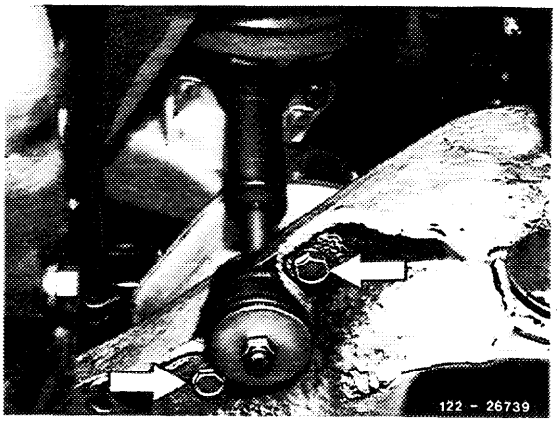
Removal

1 Remove noise capsule.

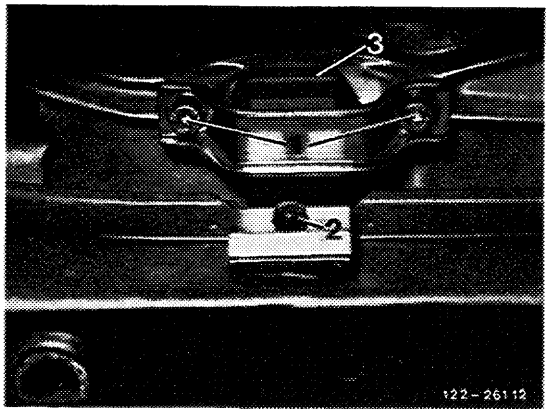
2 Drain engine oil.



3 Unscrew engine shock absorber on cross member. Unscrew fastening screws (arrows) for this purpose.

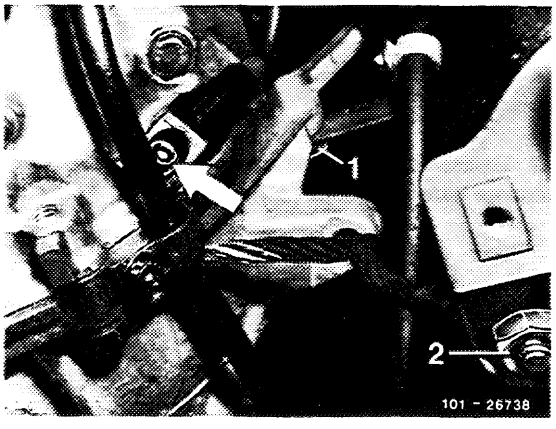


4 Remove engine stop. For this purpose, unscrew adjusting screw (2) as well as hex. screws (1) and engine stop with holder.

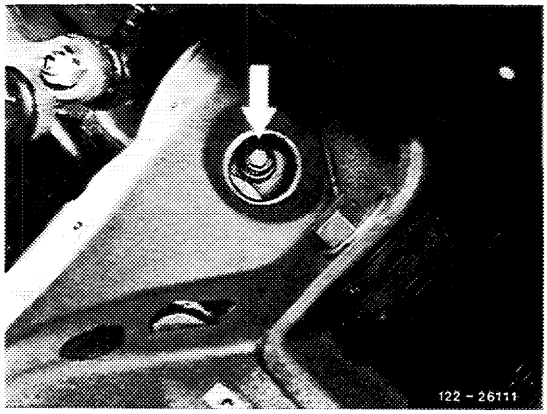


5 On vehicles with rpm sensor, disconnect line on oil pan (arrow).

6 Disconnect ground connecting line on transmission.



7 Unscrew hex. socket screws for engine carrier on both front engine mounts from below (arrow).

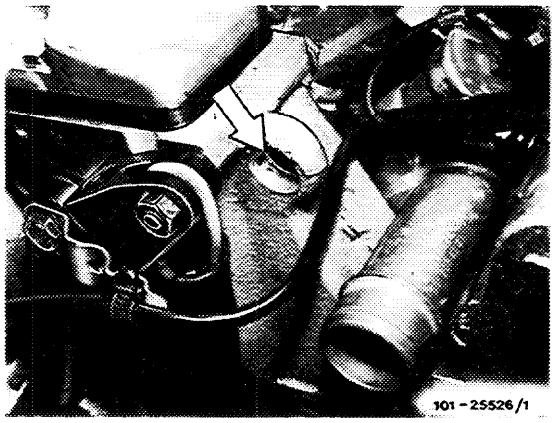


Hex. socket screw for engine carrier right

8 Unscrew torsion bar on side members right and left.

9 Engage rope of engine hoist at front suspension eye of engine (arrow).

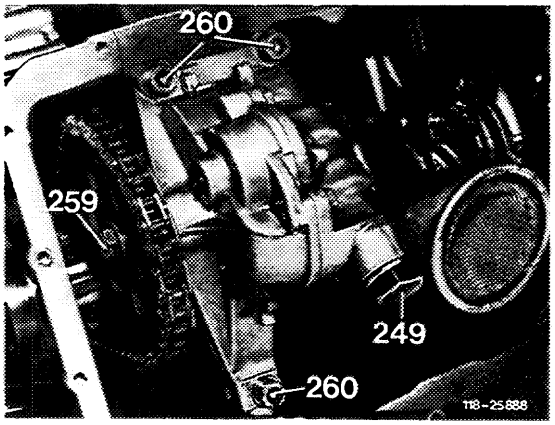
Lift engine with a crane. Pay attention to fan and fan cover.



10 Unscrew oil pan.

11 Unscrew screw (259) on sprocket and remove sprocket from drive shaft.

12 Unscrew oil pump and remove. For this purpose, unscrew fastening screws (260).



13 Remove oil pan in forward direction. Pull torsion bar down for this purpose.

14 Clean parting surfaces.

Installation

15 Place oil pan over bogie.

16 Install oil pump (18-210).

17 Mount oil pan with new gasket.

18 Lower engine and screw engine carrier to engine mount.

19 Adjust engine stop (22-220).

20 Fill in engine oil.

21 Run engine warm and check for leaks,

22 For further installation proceed vice versa.

01-405 Cylinder head screws and tightening cylinder head screws

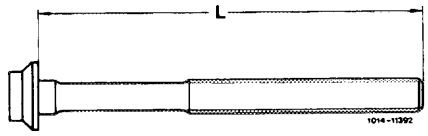
Tightening torques and angles of rotation for cylinder head screws on cold engine

Double hex. socket cylinder head screws (necked-down cylinder head screws)	1st stage	25 Nm	–
	2nd stage	40 Nm	–
	Setting interval	10 min	
	3rd stage	–	90°
	4th stage		90°

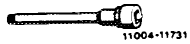
Tighten cylinder head screws M 8 with screwdriver with tommy handle.

Dimensions of double hex socket cylinder head screws

Thread dia.	Length when new	Max. length (renew)
M 10	80	83.6
M 10	102	105.6
M 10	115	118.6

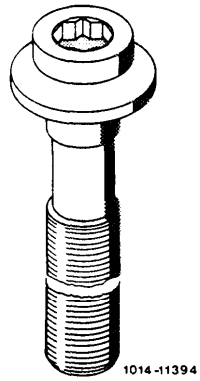


Special tools

Screwdriver element 1/2" square, 140 mm long for double hex. socket cylinder head screws M 10 on cylinder head		601 58900 1000
Screwdriver with tommy handle for hex. socket screws 6 mm, 440 mm long		116589030700
Torque wrench single-arm, emitting signal, with plug-in ratchet, 1/2" square, 25-130 Nm		001 589 66 21 00

Note

To obtain a uniform and high screw pre-tensioning force, double hex. socket — necked-down — cylinder head screws are installed with a machined flange. They have a tapered-down shank and are mounted without washers.



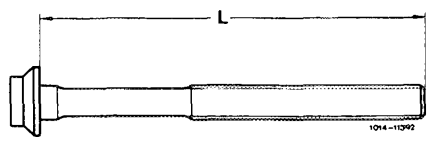
Retightening of cylinder head screws during inspection at 1000-1500 km or in the event of repairs after 1000-l 500 km is no longer required.

The double hex. socket cylinder head screws are tightened to initial torque and angle of rotation torque (refer to Table).

Since these cylinder head screws are subject to a lasting elongation after tightening, they must be renewed after the max. longitudinal dimensions named in Table shown below are exceeded.

Dimensions of cylinder head screws

Thread dia.	Lenghts when new (L)	Max. length (L) (renew)
M 10	80	83.6
M 10	102	105.6
M 10	115	118.6



Owing to the different lengths of cylinder head screws, attention must be paid to fit the bolts in the proper locations during assembly. Insert cylinder head screws according to the tightening diagram shown.

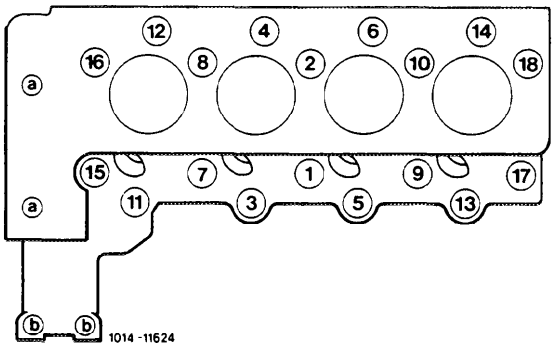
M 10 x 80 in bore 3, 5, 11, 13

M 10 x 102 in bore 2, 4, 6, 8, 10, 12, 14, 16, 18

M 10 x 115 in bore 1, 7, 9, 15, 17

M 8 x 30 in bore a

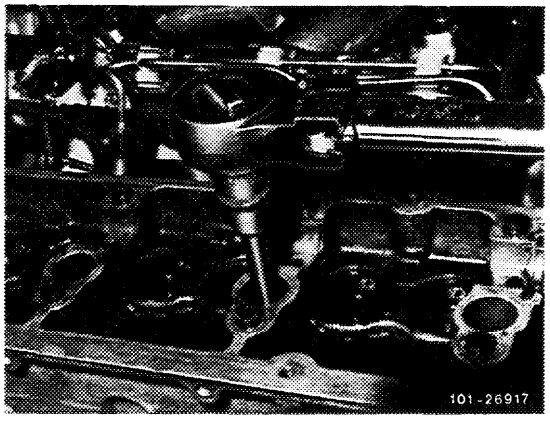
M 8 x 80 in bore b



Tighten cylinder head screws to initial torque and angle of rotation torque.

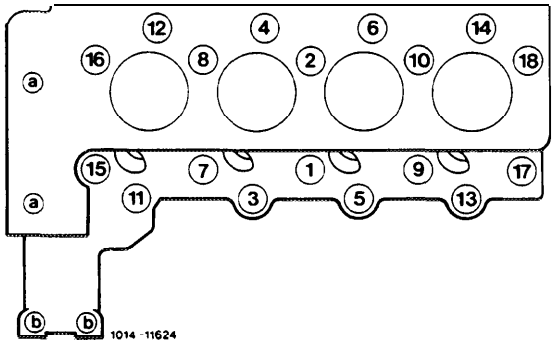
Estimate angle of rotation. For this purpose, place adjustable torque wrench in release position (locked) into plug-in ratchet. Position adjustable torque wrench with plug-in ratchet lengthwise in relation to engine and keep turning until it is transverse in relation to engine.

Do not use torsion bar torque wrench for angle of rotation.



Tighten cylinder head screws in steps in sequence of tightening pattern shown.

Do not release cylinder head screws after setting interval, but continue tightening.



After tightening according to tightening torque, a lo-minute setting interval must be maintained between the 2nd and the 3rd tightening step (refer to Table).

01-415 Removal and installation of cylinder head

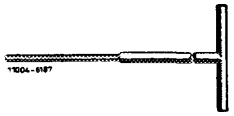
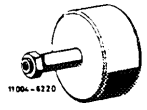
Timing at 2 mm valve lift

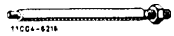
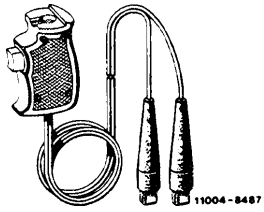
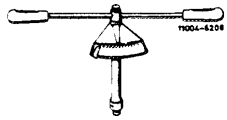
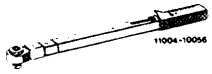
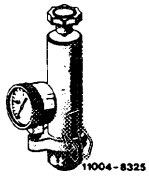
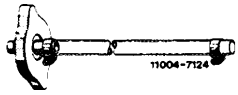
Engine	Camshaft code number[1])	Intake valve opens after TDC	Intake valve closes after BDC	Exhaust valve opens before BDC	Exhaust valve closes before TDC
601	05	with new timing chain			
		11°	17°	28°	15°
		with used timing chain (starting at approx. 20 000 km)			
		12°	18°	27°	14°

1) The camshaft code number is punched into flange of camshaft in range of TDC mark.

Tightening torques			Nm
Screws for cylinder head cover			10
Double hex. socket cylinder head screws (with cold engine)	initial torque	1st stage	25
		2nd stage	40
	setting interval	10 min	
	angle of rotation torque	3rd stage	90°
		4th stage	90°
Cylinder head screws M 8 (reference value)			25
Screw for camshaft timing gear			45
Chain tensioner			80
Coupling nuts for injection lines (reference value)			1 O-20
Hex. socket screws for intake manifold			10

Special tools

Screwdriver element 1/2'' square, 140 mm long for double hex. socket screws M 10 on cylinder head		601 589 00 10 00
Screwdriver with tommy handle for hex. socket screws 6 mm, 440 mm long		116589030700
Impact puller for bearing bolts (basic unit)		116589203300

Threaded bolt for impact puller M 6, 50 mm long		116589013400
Threaded bolt for impact puller M 6, 150 mm long		116589023400
Contact handle for rotating engine (component of compression pressure recorder 001 589 46 21 00)		001 589 46 21 08
Torque wrench, double-arm, 3/8'' square, 8-32 Nm		001 589 51 21 00
Torque wrench, single-arm, emitting signal, with plug-in ratchet 1/2'' square, 25-130 Nm		001 5896621 00
Box end wrench element, **open,** 14 mm, 1/4'' drive for coupling nut of injection line		000589770300
Tester for cooling system and radiator cap		001 589 48 21 00
Radiator cap with hose for leak test		605589002500

Conventional tool

Socket wrench hexagon 7 mm on flexible shaft for hose clamps with worm drive	e.g. Hazet, D-5630 Remscheid order no. 426-7

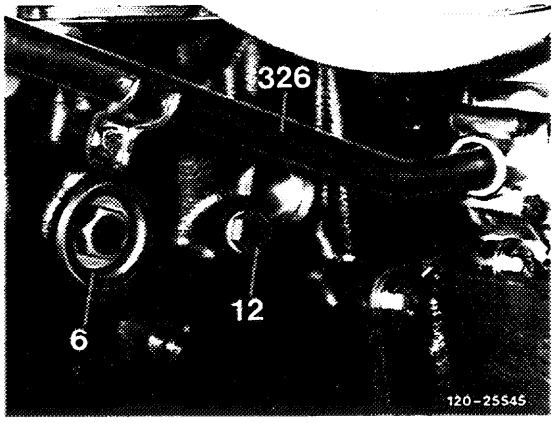
Note

Cylinder head should be removed with cooled down engine only. Remove together with exhaust manifold.

Removal

1 Set engine hood in vertical position.

2 Completely drain coolant (20-010).



12 Drain plug on cylinder crankcase

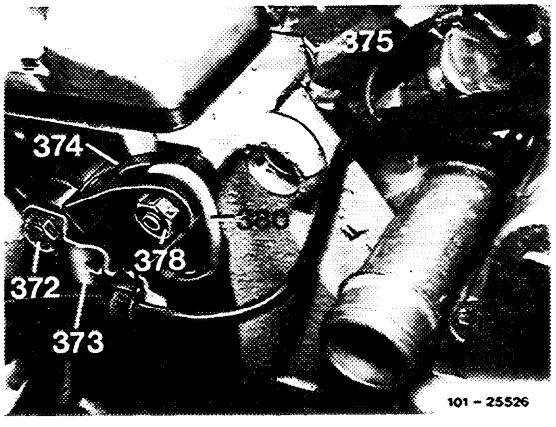
3 Disconnect negative line on battery.

4 Remove radiator (20-420).

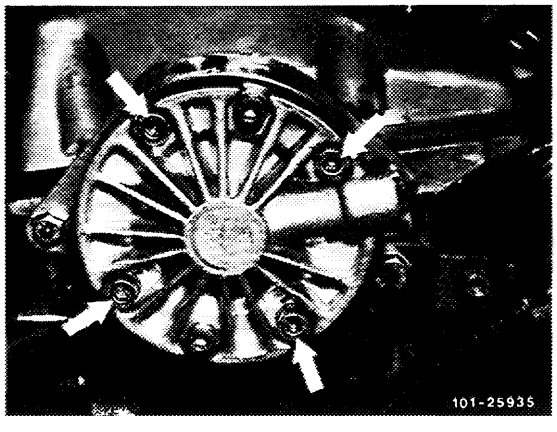
5 Completely remove air cleaner (09-410).

6 Slacken V-belt and remove. For this purpose, unscrew flange nut (378). insert a mandrel into spring tensioning lever (374) and relieve hex. screw (375) in relation to draw spring (380) until spring can be pushed back in direction of intake manifold.

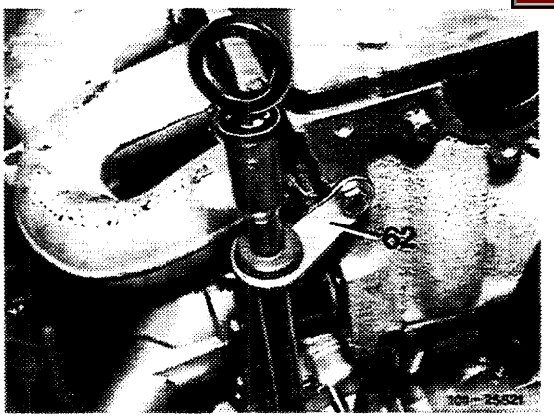
7 Unscrew hex. screw (372) for fastening shock absorber.



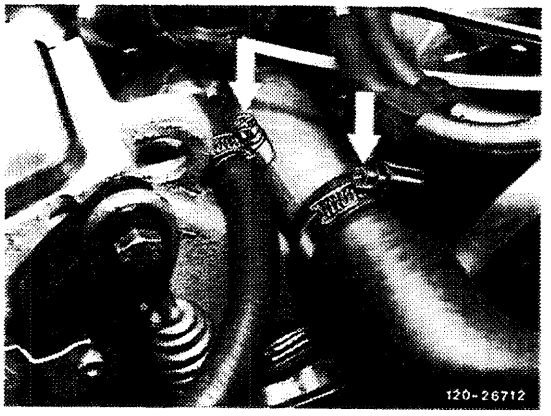
8 On vehicles with level control, unscrew hex. socket screws (arrows), place pressure oil pump with connected lines aside. Remove driver.



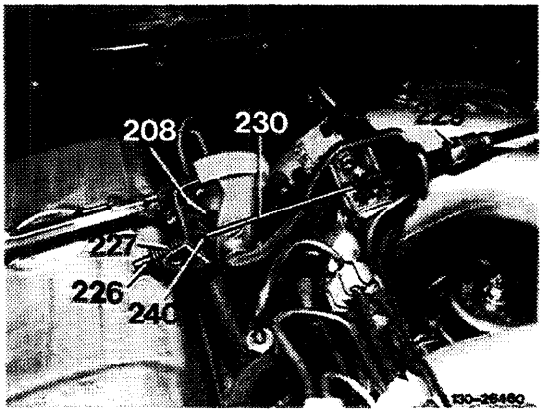
) Unscrew holder (62) for oil dipstick guide tube.



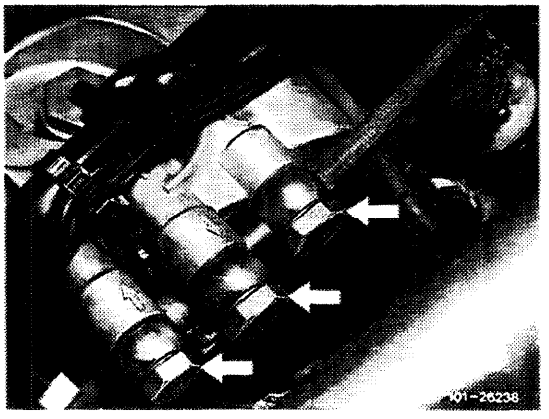
10 Disconnect coolant hoses (arrows) on coolant outlet connection and pull cable from temperature witch.



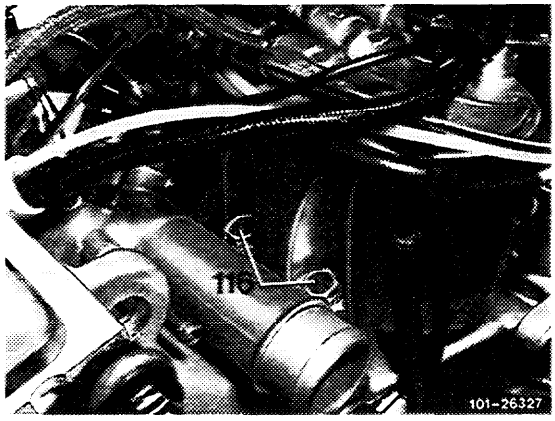
11 Disengage bowden *wire* (230) for engine regulation. For this purpose, push out slotted guide piece 240) on angle lever and remove bowden wire,



12 Pinch fuel lines and unscrew at fuel filter arrows).

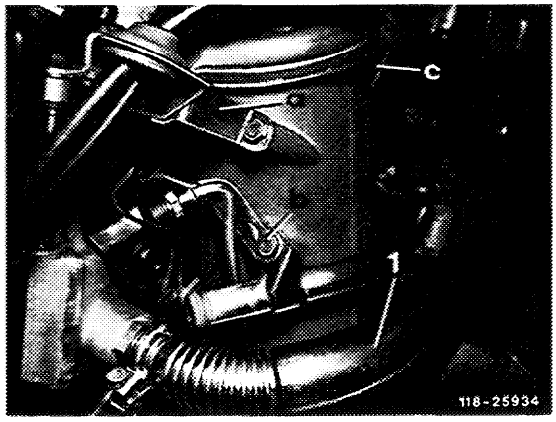


13 Unscrew both fastening screws (116) and remove fuel filter.



14 On engines with EGR, remove pipe line (1) between EGR valve and exhaust manifold.

15 Unscrew exhaust flange from exhaust manifold.



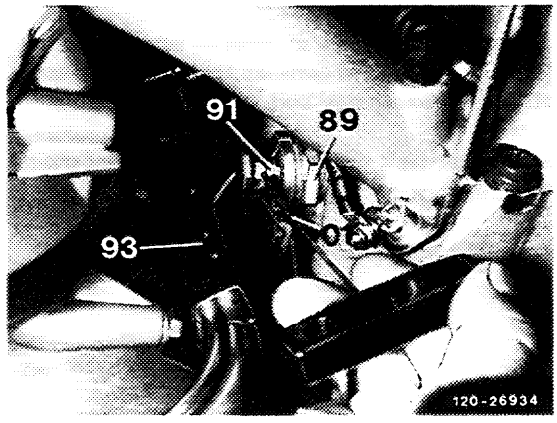
16 Remove injection lines.

17 Remove intake manifold.

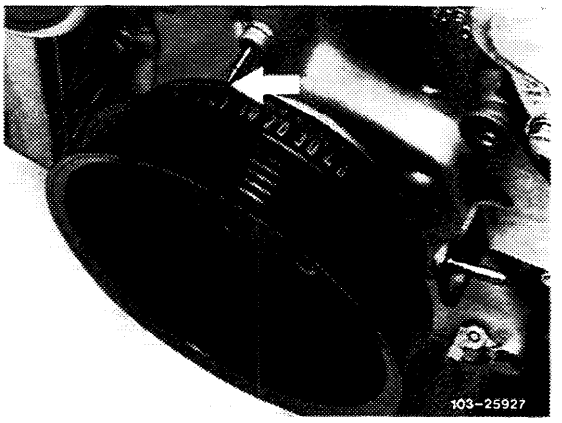
18 Remove cylinder head cover.

19 Pull off lock (91) for heater feed line (by means of a hook [01].

20 Unscrew pipe elbow (93) on oil filter and pull from connection (89).



21 Unscrew electric lines on pencil element glow plugs.

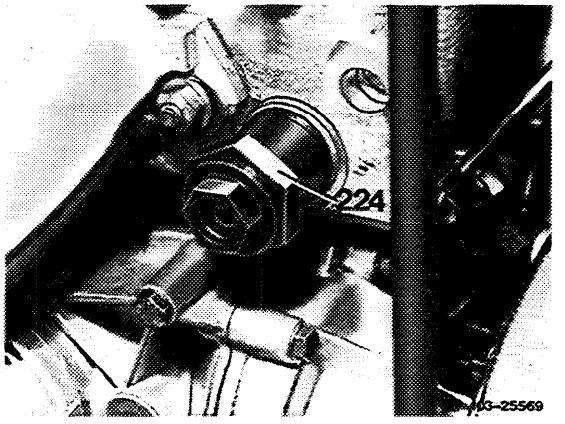


22 Set engine to ignition TDC of 1st cylinder.

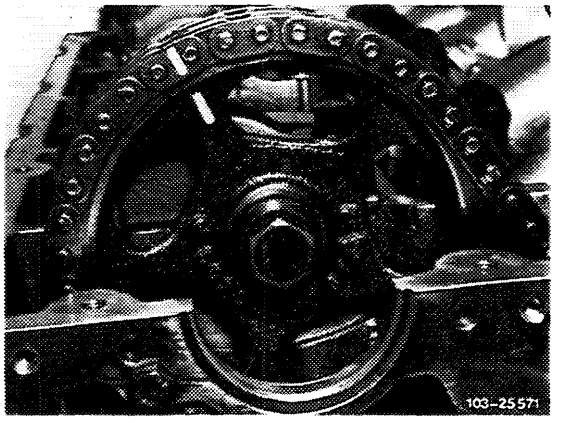
Attention!
Do not rotate engine at fastening screw of camshaft timing gear.

Do not rotate engine in reverse.

23 Completely remove chain tensioner (224) (05–310).



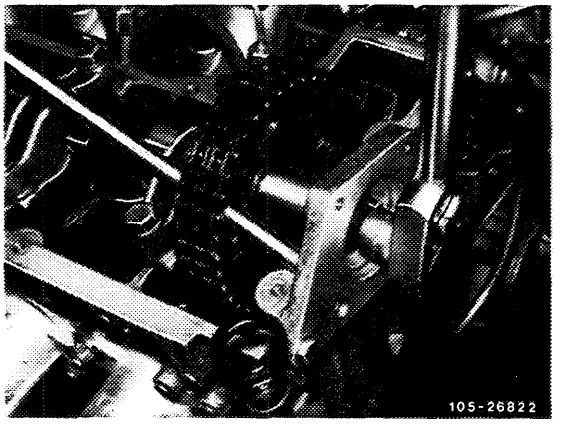
24 Mark camshaft timing gear and timing chain in relation to each other.



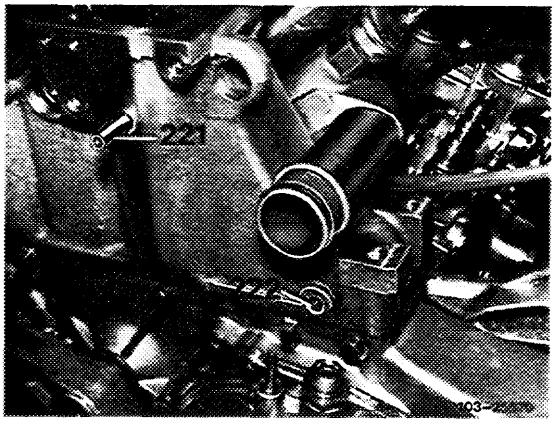
25 Remove camshaft (05–220). For this purpose, unscrew fastening screw of camshaft timing gear. Apply counterhold to camshaft timing gear by means of a screwdriver or steel bolt

Remove camshaft timing gear and lower timing chain into chain box.

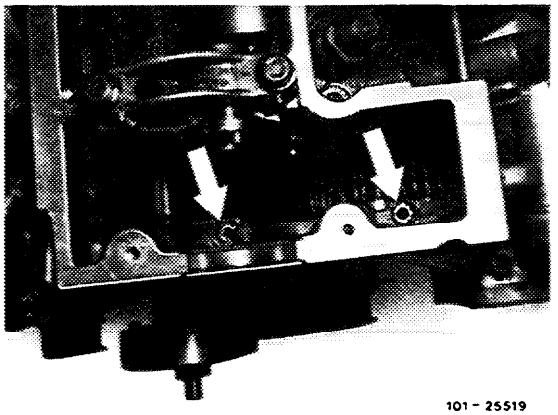
Note: Uniformly loosen all camshaft bearing caps.



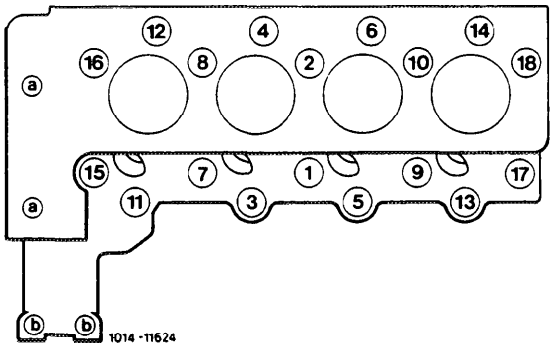
26 Knock out slide rail bolts (221 and 222) with impact puller and remove guide rail.



27 Unscrew both cylinder head screws M 8 (arrows) with screwdriver.



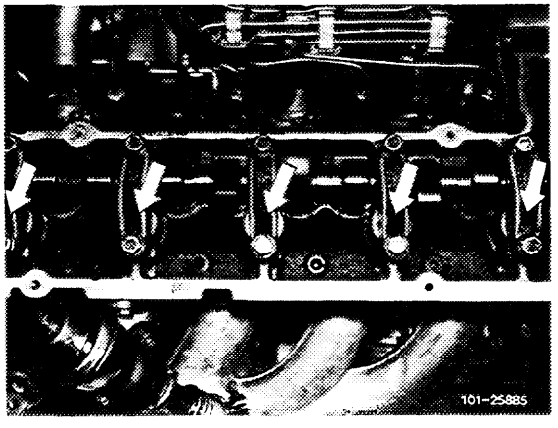
28 Loosen cylinder head screws in vice versa sequence of tightening diagram by means of screwdriver and unscrew.



Note: Cylinder head screws 2, 8, 10, 16 and 18 are located in shafts of camshaft bearing brackets (arrows).

29 Lift off cylinder head.

30 Clean cylinder crankcase and cylinder head parting surfaces.

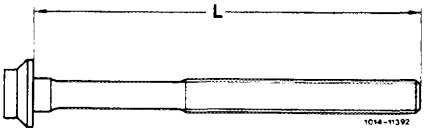


Installation

31 Mount new cylinder head gasket.

32 Mount cylinder head. Pay attention to clamping sleeve for locating cylinder head.

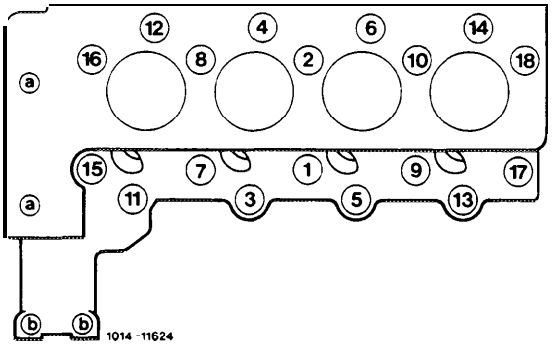
33 Measure length (L) of cylinder head screws. If the dimension named in Table is exceeded, use new cylinder head screws (01–405).



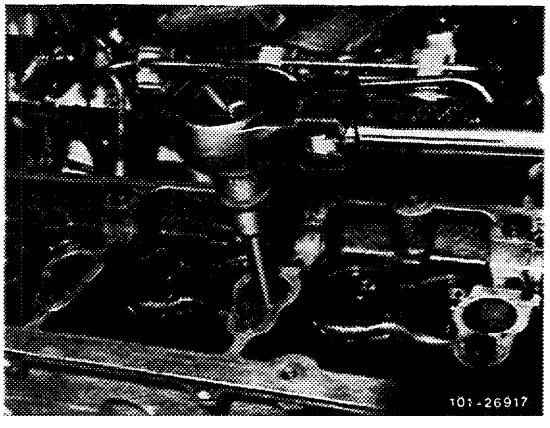
Thread dia.	Length (L) when new	Max. length (L)
M 10	80	83.6
M 10	102	105.6
M 10	115	118.6

34 Lubricate cylinder head screws on threads and on head contact surface and insert.

35 Tighten cylinder head screws in steps in sequence of tightening diagram, starting with screw 1.



Attention!
Tighten cylinder head screws to initial torque and angle of rotation torque (01-405).
Estimate angle of rotation. For this purpose, place adjustable torque wrench in release position (locked) into plug-in ratchet. Position adjustable torque wrench with plug-in ratchet lengthwise in relation to engine and keep turning until it is transverse in relation to engine.

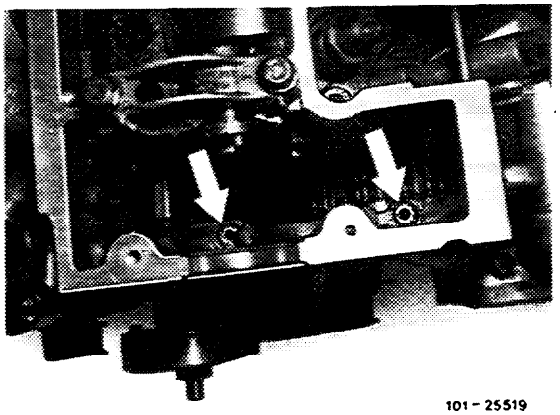


Do not use torsion bar torque wrench.

Tightening torques and angle of rotation torque of cylinder head screws

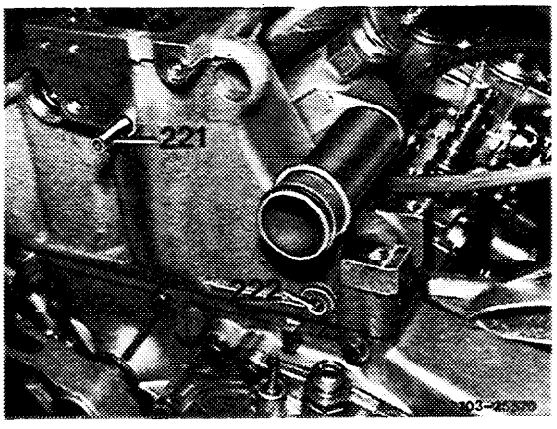
1st stage	**25** Nm
2nd stage	40 Nm
Setting interval	10 min
3rd stage	90°
4th stage	90°

36 Tighten screws M 8 (arrows) by means of screwdriver with tommy handle.



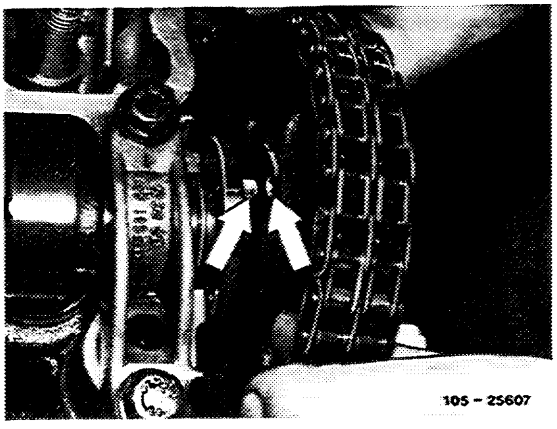
101 - 25519

37 Install guide rail for timing chain. For this purpose, insert slide rail bolts (221 and 222) into cylinder head.



38 Install camshaft, while paying attention to color mark.

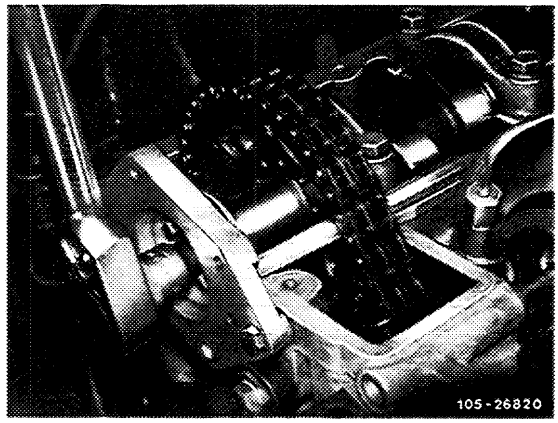
Note: The camshaft timing gear is centered by means of a cylindrical pin (arrows).



105 - 25607

39 Position fastening screw of camshaft timing gear and tighten to 45 Nm.

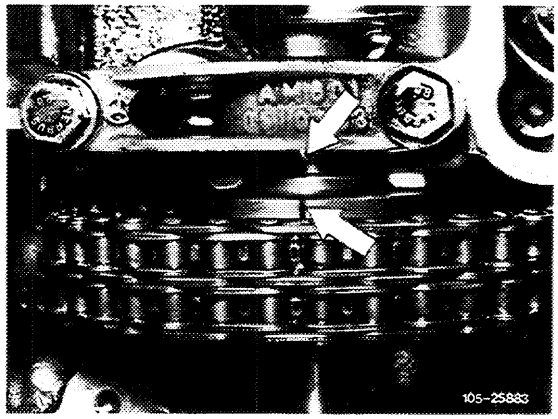
For this purpose, apply counterhold to camshaft timing gear with a screwdriver or steel pin.



40 Install chain tensioner and tighten to 80 Nm.

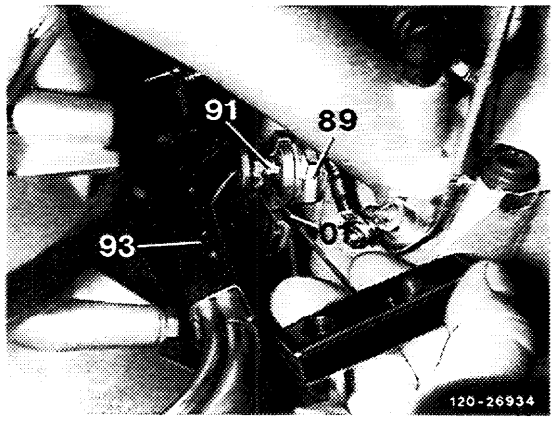
41 Rotate engine and set to ignition TDC of 1st cylinder. Check adjusting marks.

The notch in flange of camshaft must be in alignment with (cast-on) lug on cylinder head (arrow).



42 Mount electric lines for pencil element glow plugs.

43 Mount pipe elbow (93) with new O-ring.

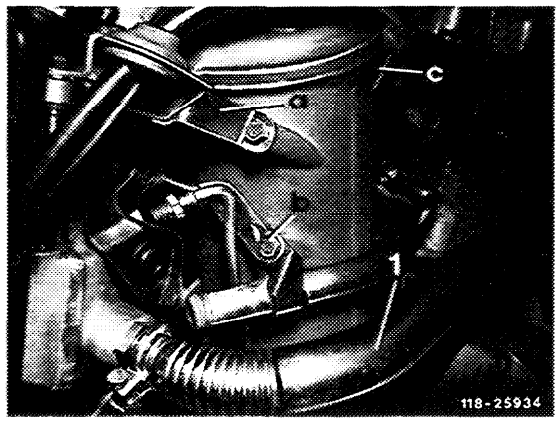


44 Install intake manifold.

45 Install injection lines.

46 Screw exhaust system to exhaust manifold.

47 On vehicles with EGR, install pipe line (1) between EGR valve and exhaust manifold.

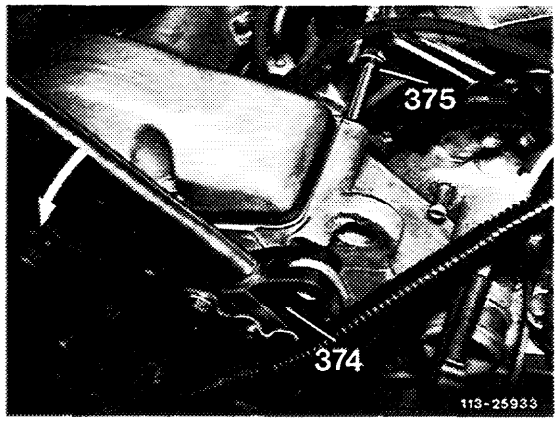


48 Install fuel filter and fuel lines,

49 Screw on holder for oil dipstick guide tube.

50 On vehicles with level control, mount pressure oil pump and driver.

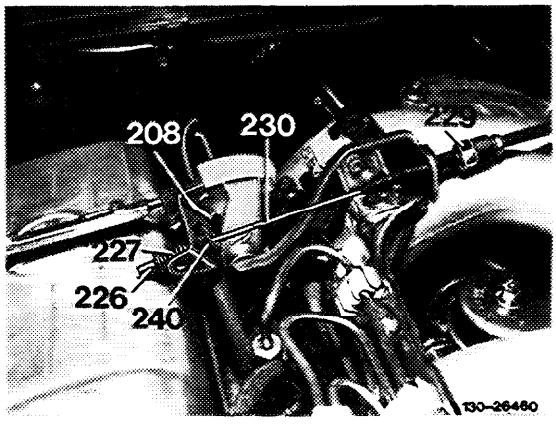
51 Mount tensioning device for V-belt. For this purpose, swivel spring tensioning lever (374) by means of a mandrel against force of draw spring (380) to the left until screw (375) can be pushed through spring tensioning lever. Position collar nut and tighten.



52 Mount cylinder head cover.

53 Engage bowden wire for engine regulation and adjust, if required (30-300).

54 Plug on cable for temperature switch.



55 For further installation proceed vice versa.

56 Fill in coolant (20-010) and pressure-test cooling system.

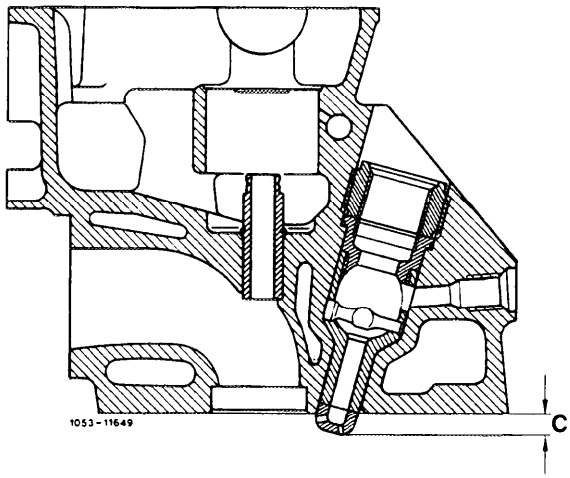
57 Run engine and check for leaks.

Note: Retightening of cylinder head screws is not required.

01-417 Removal and installation of prechambers

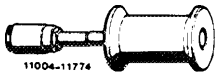
Data

hechamber standout on cylinder head
dimension "c" 7.6-8.1 mm



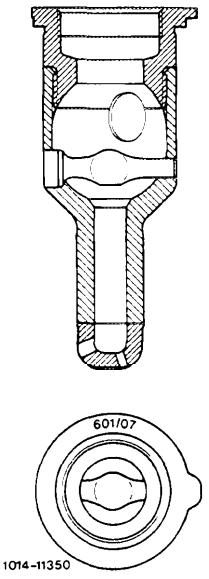
Tightening torques	Nm
Coupling nuts of injection lines (reference value)	1 O-20
Screws for cylinder head cover	10
Prechamber in cylinder head (threaded ring)	100 ± 10
Nozzle holder in prechamber	70 + 10

Special tools

Box end wrench element, open, 14 mm, 1/4" drive, for coupling nut of injection line	11004-10520n	000589770300
Wrench element for threaded ring of prechamber	11004-6360	615 589 00 07 00
Socket wrench element 27 mm, 1/2" square		001 589 65 09 00
Impact puller for prechamber	 11004-11774	601 589 06 33 00

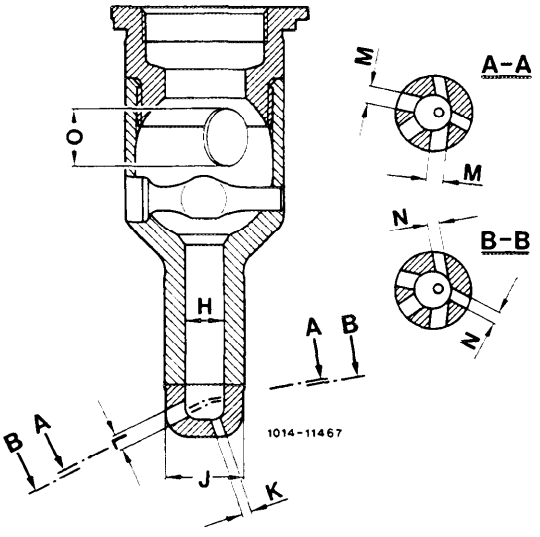
Note

The prechamber is identified at upper flange with code number 601/07.



6 burner bores of different diameter are located on prechamber lower half (burner neck) at different levels and angle positions.

The firing duct (H) has a diameter of 7 mm and the burner neck (J) of 14 mm.



H Firing duct	7.0 mm dia.
J Burner neck	14.0 mm dia.
K Burner bore	1.5 mm dia.
L Burner bore	2.0 mm dia.
M Burner bore	3.2 mm dia.
N Burner bore	3.0 mm dia.
0 Bore for glow plug	10.0 mm dia.

In **addition, the prechamber floor is designed as a spherical depression.**

This spherical shape provides uniform wall thicknesses in range of burner bores.

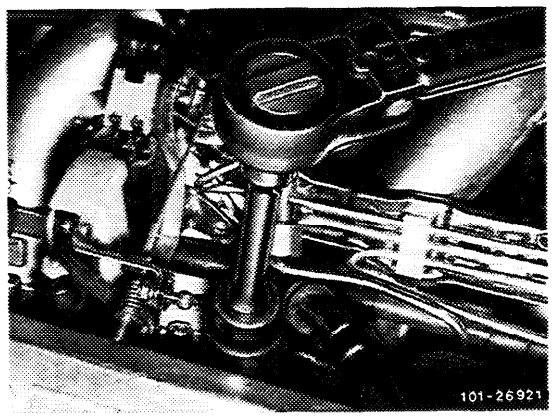
Removal

1 Unscrew injection lines from injection nozzles and loosen holder for injection lines on intake manifold.

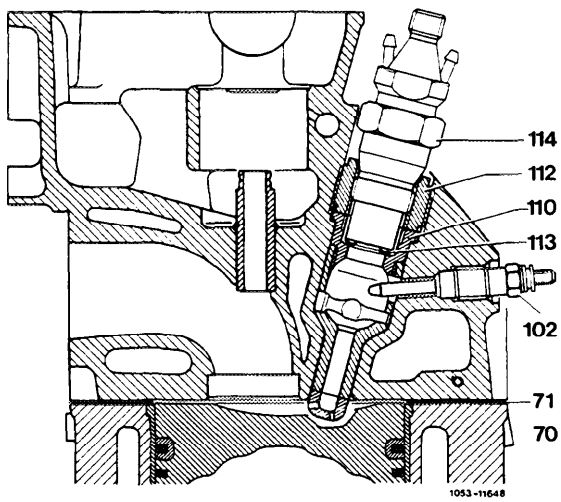
2 Pull fuel return flow hoses from injection nozzles.

3 Unscrew holder for bowden wire of engine regulation and put aside.

4 Unscrew nozzle holder complete with socket wrench element (27 mm).



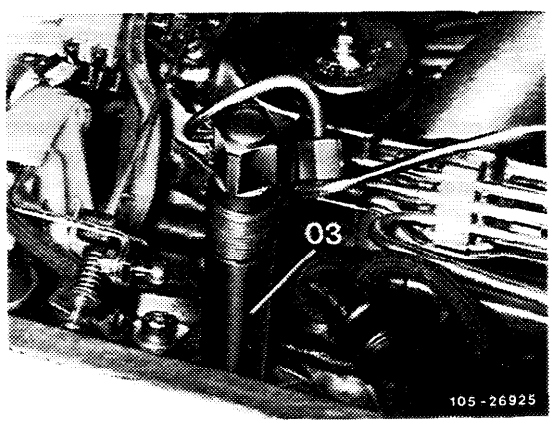
5 Remove pencil element glow plugs.



70 Cylinder crankcase
71 Cylinder head gasket
102 Pencil element glow plug
110 Prechamber
112 Threaded ring
113 Nozzle reed
114 Nozzle holder

6 Unscrew threaded ring (112) with pin wrench.

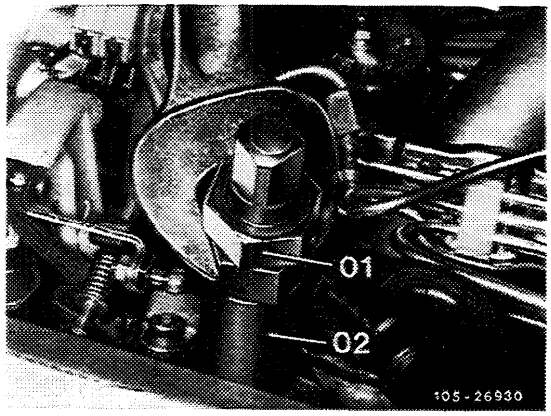
For this purpose, screw threaded member (03) into threaded ring, place sleeve (02) into grooves of threaded ring (arrows) and tighten with nut (01).



03 Threaded member

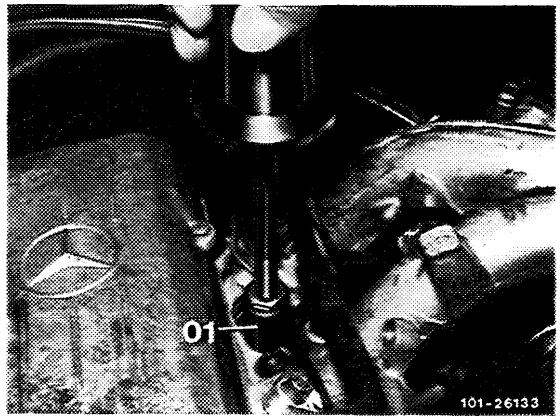
Sleeve (02) should be tight enough in grooves, so that it will not slip out of grooves when loosening threaded ring.

Insert wrench at hexagon of sleeve (02) and unscrew threaded ring.



01 Nut
02 Sleeve

7 Pull out prechamber with impact puller, part no. 601 589 06 33 00.



8 Cover bore in cylinder head.

Installation

Note: If the removed prechambers are again installed, check for perfect condition.

Ball pin should not be burnt or covered with scale.

In addition, if the burner tops are showing burn marks or cracks are showing in prechamber lower half, remove intake manifold and check inside for traces of oil.

If oil moistened spots are found, check vacuum pump for damage or renew vacuum control unit on injection pump.

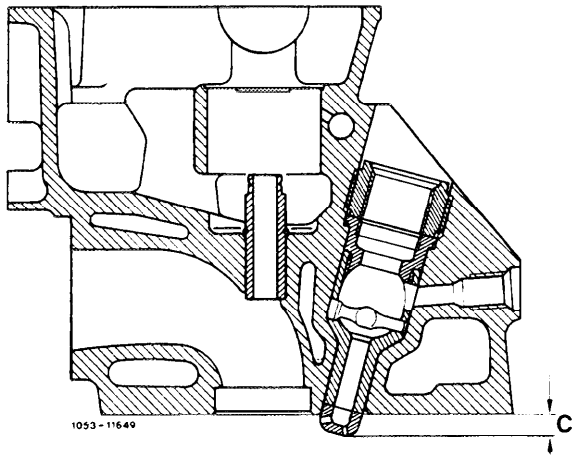
The vacuum lines (blackened by oil) are showing which of the two parts of the unit has failed.

If a cylinder head is faced at parting surface, the required distance (c) of 7.6-8.1 mm must be maintained.

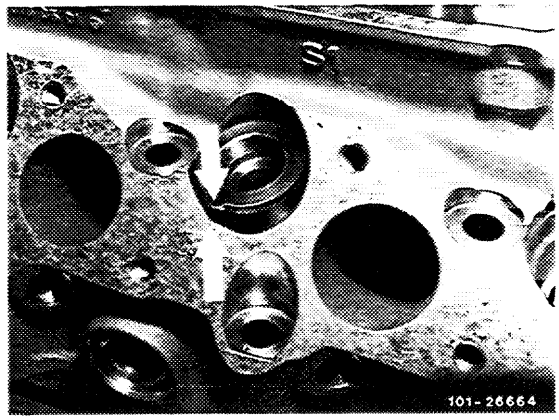
For this purpose, select appropriate sealing ring and insert between cylinder head and prechamber.

The following sealing rings are available:

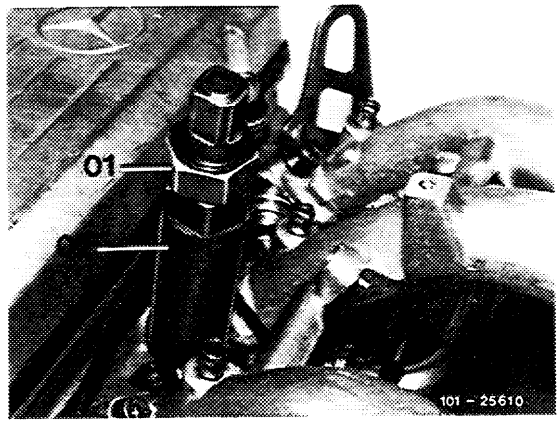
Thickness	Part no.



9 Position prechamber in such a manner that the lug is pointing toward recess in cylinder head (arrows).



10 Lubricate threaded ring (112 in Fig. item 5) and tighten with pin wrench to specified tightening torque (90-l 10 Nm).



11 Screw in glow plugs (102) and connect.

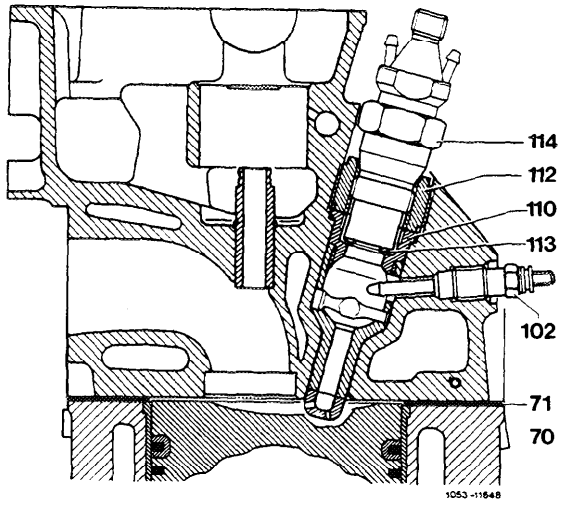
12 Insert new nozzle reed (113).

13 Completely screw in nozzle holder (114) and tighten to 70-80 Nm.

14 Plug fuel return hoses on injection lines.

15 Mount injection lines.

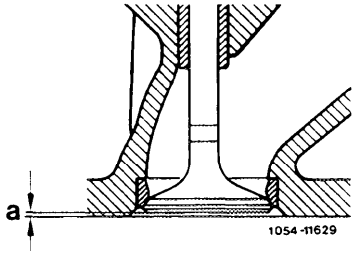
16 Screw on holder for bowden wire of engine regulation and adjust bowden wire, if required (30–300).



70 Cylinder crankcase
71 Cylinder head gasket
102 Pencil element glow plug
110 Prechamber
112 Threaded ring
113 Nozzle feed
114 Nozzle holder

01-418 Facing cylinder head parting surface

Data		
Total height of cylinder head		142-144
Minimum height after machining		
Permissible unevenness of parting surfaces	in longitudinal direction	0.08
	in transverse direction	0.0
Permissible deviation in parallel of upper parting surface in relation to lower surface in longitudinal direction		0.1
Roughness		0.016
Test pressure with air under water in bar gauge pressure		2
Minimum distance "a" with new valves and new valve seats		
	intake	+0.17 to -0.23
	exhaust	+O. 12 to -0.28
Max. distance "a" (depth) on new valves and machined valve seats		
	intake	1.0
	exhaust	

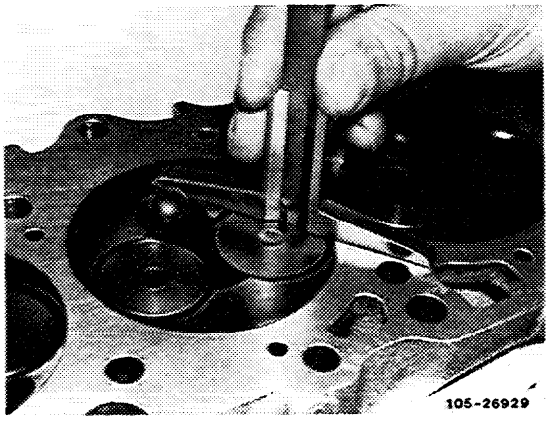


Facing

1 Face cylinder head parting surface.

2 Refinish valve seats until minimum distance "a" has been attained.

3 Check timing (05—215).

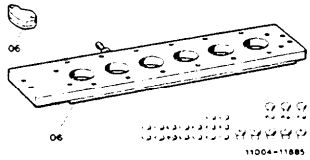
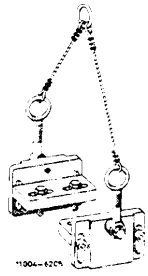


01-420 Pressure-testing cylinder head

Data

Test pressure with air under water in bar gauge pressure	2

Special tools

Pressure plate		601 589 00 25 00
Suspension device		115589346300

Conventional tool

Electrically heated water basin	e.g. Otto Dürr, D-71 23 Sachsenheim-Ochsenbach

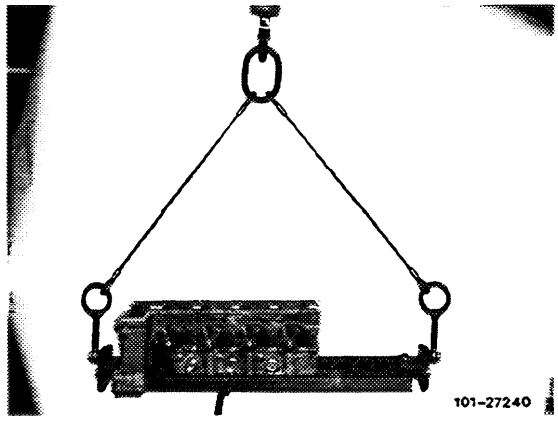
Pressure-testing

Pressure-test cylinder head if cracks (coolant losses) are suspected.

1 Screw pressure plate on cleaned cylinder head.

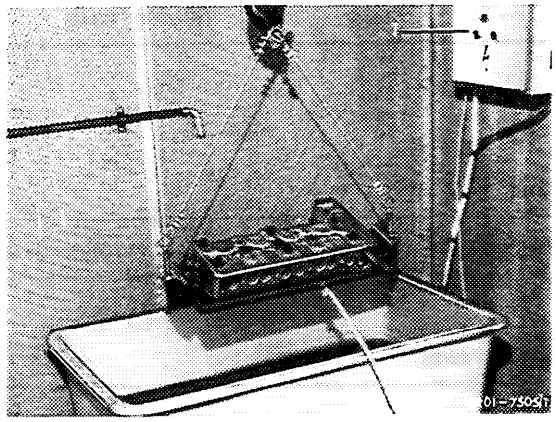
2 Close bores and connections.

3 Connect compressed air hose (1) and regulate compressed air to 2 bar gauge pressure.



4 Fasten cylinder head on suspension device and immerse into heated water basin (80 °C).

5 When air bubbles are rising, find leaking spot.



Crankshaft assembly 03

03 Crankshaft assembly

	Job No.
Crankshafts, connecting rods and pistons	
Checking, renewing and tightening connecting rod bolts	03-310
Reconditioning and squaring connecting rods	313
Removal and installation of pistons	316
Checking and reconditioning of crankshaft	318
Mounting of crankshaft	320
Replacing front crankshaft radial sealing ring	324
Replacing rear crankshaft radial sealing ring	327
Removal and installation of radial ball bearing in crankshaft	330
Removal and installation of crankshaft pulley at hub	341
Checking and correcting adjustment of TDC transmitter	345
Removal and installation of crankshaft timing gear.	350
Flywheel of driven plate and ring gear	
Removal and installation of flywheel and driven plate	410
Refinishing of flywheel	420
Renewing ring gear of flywheel	430

03-3 10 Checking, renewing and tightening connecting rod bolts

Dimensions of connecting rod bolt

Part no.	Thread dia.	Necked-down shank dia. c when new (Fig. item 1)	Minimum necked-down shank dia. c
601 038 01 71	M 9 x 1	7.4-o. 1	7.1

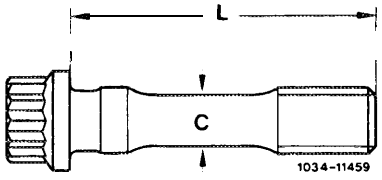
Tightening connecting rod bolt

Initial torque	30 + 5 Nm
Angle of rotation torque	90-I 00”

Checking

1 Measure minimum necked-down shank dia. prior to re-use.

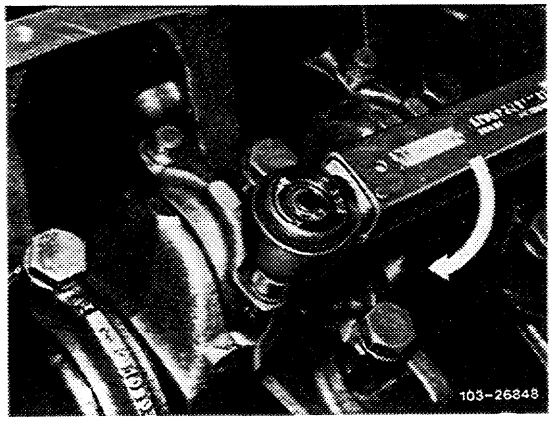
Note: If the minimum necked-down shank dia. of 7.1 mm is attained or less, renew connecting rod bolt.



Tightening

2 Lubricate threads and screw head contact area.

3 Tighten connecting rod bolt to 30 **Nm initial torque and 90–100° angle of rotation torque.**



Note: Estimate angle of rotation. For this purpose, place adjustable torque wrench **in release position** (locked) into plug-in ratchet. Position adjustable torque wrench with plug-in ratchet lengthwise in relation to engine and keep turning until it is transverse in relation to engine.

03-313 Reconditioning and squaring connecting rods

Data

Center of connecting rod bearing bore to center of connecting rod bushing bore	engine 601.911	148.97 149.03
	engine 60 1.92 1	144.97 145.03
Width of connecting rod (B) at connecting rod bearing bore and connecting rod bushing bore		23.835 24.165
Basic bore for connecting rod bearing shells		5 1.600 51.619
Basic bore for connecting rod bushing	standard dimension	29.500 29.521
	repair stage	
Connecting rod bushing OD	standard dimension	29.560 29.600
	repair stage	
Connecting rod bushing ID		27.018 27.024
Roughness of connecting rod bushing, inside		0.004
Permissible offset of connecting rod bearing bore in relation to connecting rod bushing bore with reference to 100 mm length		0.1
Permissible deviation of parallel axle alignment: Connecting rod bearing bore in relation to connecting rod bushing bore with reference to 100 mm length		0.045
Permissible difference in weight of complete connecting rods within one engine		5 g

Tightening torque

Connecting rod bolts	initial torque	30 + 5 Nm
	angle of rotation	90-l 00"

Special tool

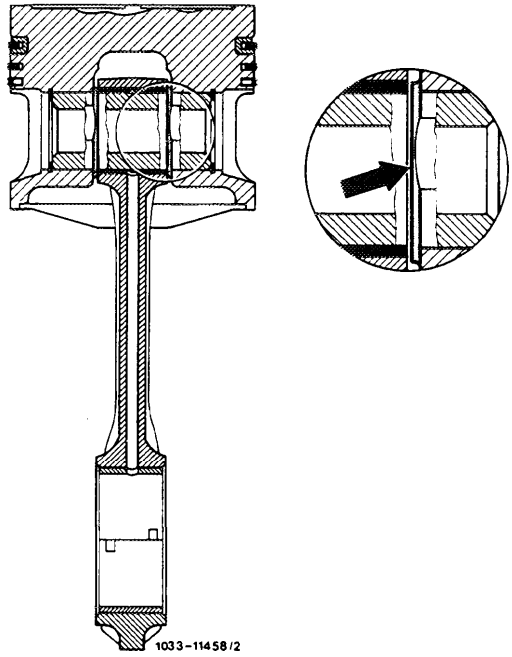
Torque wrench, single-arm, emitting signal, with plug-in ratchet, 1/2" square, 25-130 Nm		001 589 66 21 00

Conventional tool

Connecting rod straightener	e.g. Hahn & Kolb, D-7000 Stuttgart model BC 503

Note

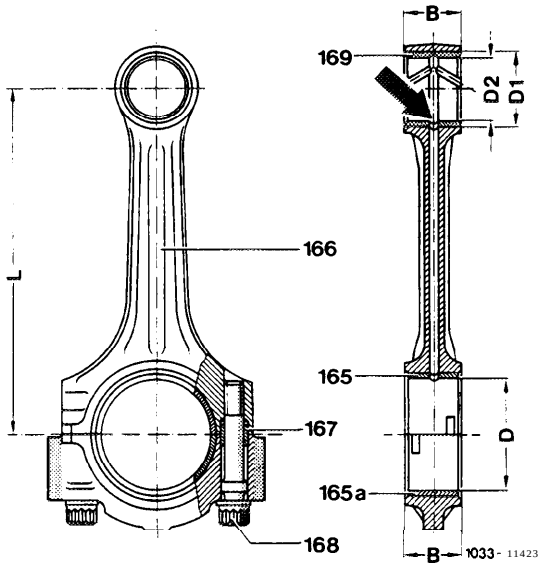
End play of connecting rods is not limited at crankshaft journals, but at piston pin eyes (piston-guided connecting rods). For this purpose, thrust surfaces (arrow) are cast onto piston pin eyes.



Connecting rod bearing and connecting rod bushing bores (B) are of similar width.

A weight compensation is attached at left and right on connecting rod bearing cap.

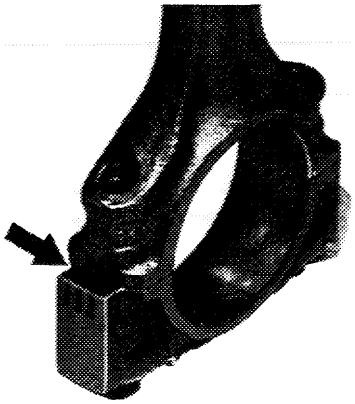
Only connecting rods of similar weight may be installed in one engine.



Connecting rods, which have become overheated as a result of bearing damage (blue coloring), may no longer be used.

Connecting rod and connecting rod bearing cap are marked together. There should be no transverse score marks and notches on connecting rod shaft.

As a spare part, connecting rods with machined connecting rod bushing are available.



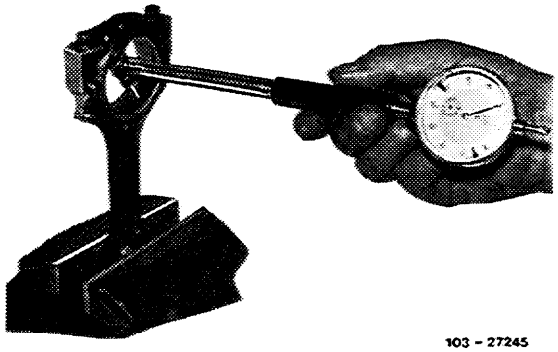
103-26488

Reconditioning

1 Check connecting rod screws and renew, if required (03-310).

2 Mount connecting rod bearing caps. For this purpose, lubricate threads and screw head contact surface and tighten to 30 + 5 Nm.

3 Measure connecting rod bearing basic bore. At a basic bore which exceeds the value of 51.619 mm or is conical, touch up bearing cap at its contact surface on a surface plate up to max. 0.02 mm.



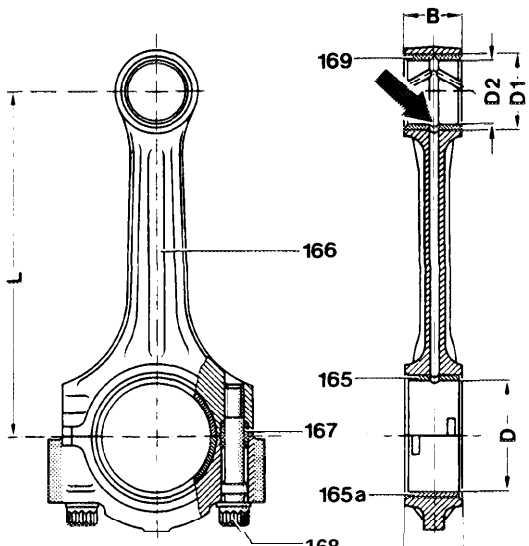
103-27245

4 Press in new connecting rod bushing in such a manner that the oil bores are in alignment (arrow).

Pressing-in pressure 2450 N.

5 Machine or ream connecting rod bushing.

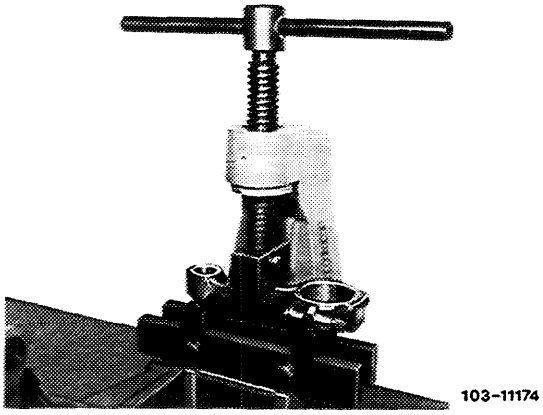
6 Touch up lateral thrust surfaces of connecting rod on surface plate.



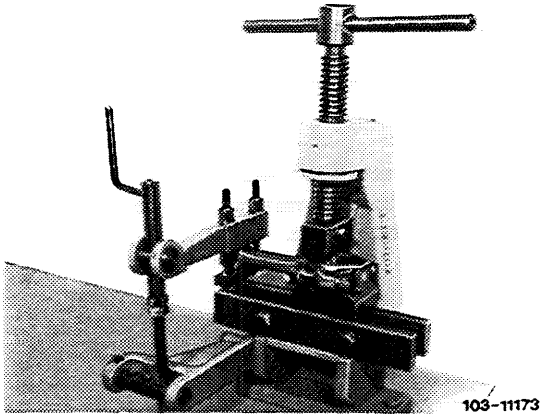
Squaring

7 Square connecting rod with a connecting rod tester.

8 Align connecting rod bearing bore in relation to connecting rod bushing bore (parallel alignment).



9 Check offset of connecting rod bearing bore in relation to connecting rod bushing bore and correct, if required.



Association piston – cylinder

Engine	Piston code number	Group code letter	Normal dimension std (standard) piston dia.	cylinder dia.
601.911	01	A	86.970-86.976	87 .OOO-87.006
		X	above 86.975-86.983	above 87.006-87.012
601.921	04	B	above 86.982-86.988	above 87.012-87.018

Piston standout

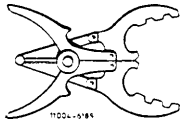
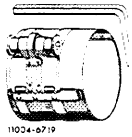
Distance between piston crown and cylinder crankcase parting surface	standout max. 0.96 standout min. 0.73

Test values		when new	wear limit
Piston clearance		0.017-0.043	0.12
Difference in weight of pistons in one engine		6 g	10 g
Piston pin dia.		26.995-27.000	
Piston pin clearance	in connecting rod bushing	0.018-0.029	
	in piston	0.004-0.015	
Connecting rod in piston (end play)		0.083-0.314	
Gap clearance of piston rings	groove 1	0.20-0.40	1.5
	groove 2	0.20-0.40	1.0
	groove 3	0.20-0.40	1.0
Side clearance of piston rings	groove 1	0.090-O. 120	0.20
	groove 2	0.050-0.080	0.15
	groove 3	0.030-0.065	0.1

Tightening torque

Connecting rod screws	initial torque	30 + 5 Nm
	angle of rotation torque	90-I 00”

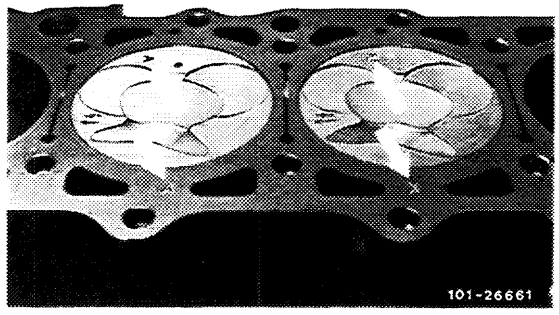
Special tools

Spreaders for piston rings		000 589 51 37 00
Clamping strap for piston rings		000 589 04 14 00

Note

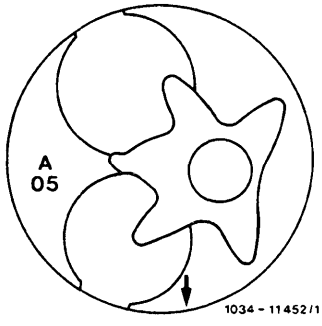
The group code letter A, X or B, the piston code number 05 or 06 and the driving direction arrow are punched into piston crown.

The group code letter is also punched into cylinder crankcase parting surface.

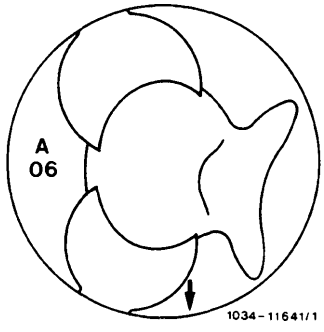


For repairs, only pistons with group code letters "X" are available, These pistons are also for installation in cylinder bores with group code letters "A" or "B".

In the event of repairs, hone cylinder bores according to dimensions of available pistons "X" plus piston clearance.



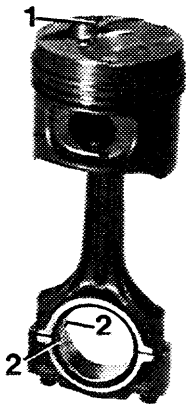
Engine **601.911**



Engine 601.921

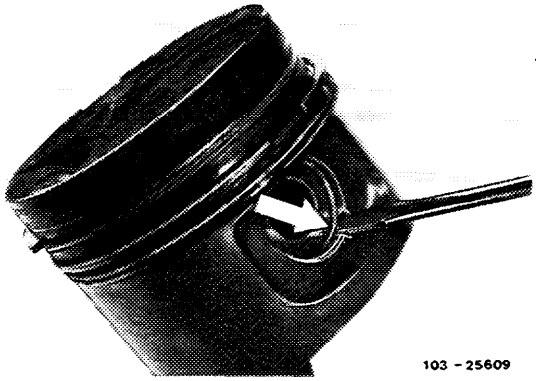
Removal

1 **Remove connecting rod with piston in upward direction.**

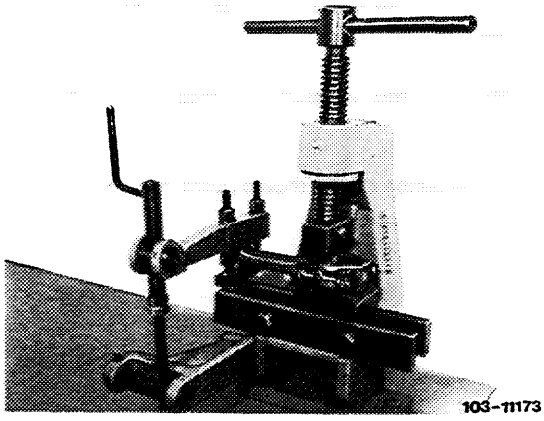


103-26983

2 **Remove piston pin circlip and push out piston pin.**


103 - 25609

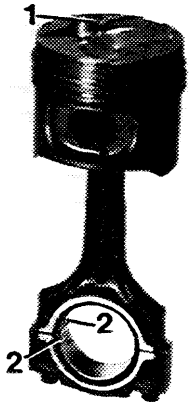
3 **Recondition connecting rod and square (03-313).**


103-11173

Installation

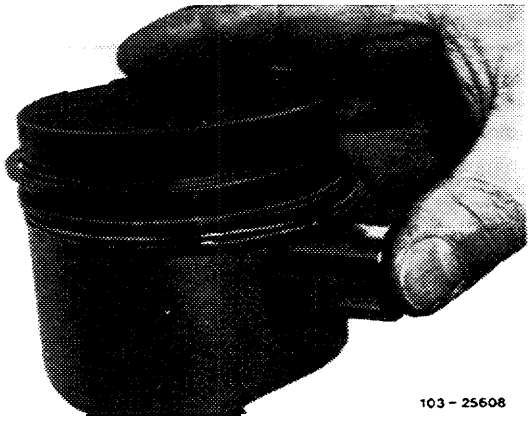
4 **Place piston on connecting rod in such a manner that arrow (1) points in driving direction and locking grooves (2) in connecting rod to lefthand engine side.**

Attention!
Do not heat pistons.



103-26983

5 Push in piston pins provided with engine oil manually.

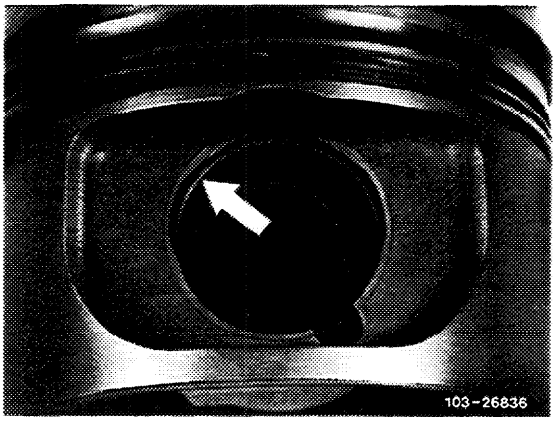


6 Insert piston pin circlip into groove.

Check piston rings for easy operation.

When installing used pistons, check piston rings for gap and side clearance.

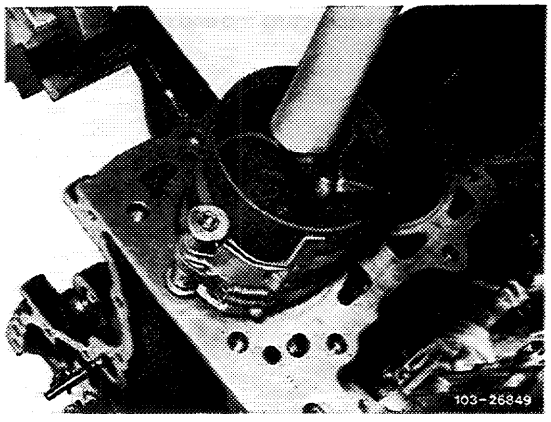
7 Lubricate cleaned cylinder bores, connecting rod bearing journals, connecting rod bearing shells and pistons.



8 Distribute gaps of piston rings uniformly along piston circumference.

9 Mount piston ring clamping strap and introduce pistons.

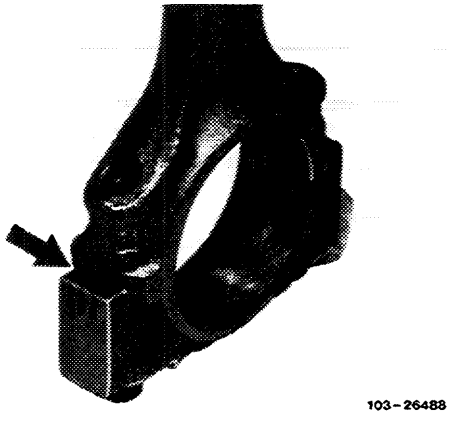
Arrow in piston crown should point in driving direction.



10 Mount connecting rod bearing caps with code numbers (arrow) in relation to each other on connecting rod. Lubricate threads and screw head contact surface of connecting rod screws and tighten to 30 Nm and 90–100° angle of rotation torque.

11 Rotate crankshaft and check clearance between connecting rod and crankshaft.

12 Measure distance between piston crown and cylinder crankcase parting surface in TDC position of pistons (refer to Table).



Data

Crankshaft normal dimension and repair stages	Crankshaft bearing journal dia.	Fitted bearing Associated thickness of thrust washers	Width of journal	Crankpin dia.	Crankpin width
Standard dimension	57.950 / 57.965	2,15	26.52 / 26.50	47.950 / 47.965	27.96 / 28.04
		2.20	26.62 / 26.60		
1st repair stage	57.700 / 57.715	2.25 or 2.35 or 2.40	26.72 / 26.70 or 26.92 / 26.90 or 27.02 / 27.00	47.700 / 47.715	up to 28.30
2nd repair stage	57.450 / 57.465			47.450 / 47.650	
3rd repair stage	57.200 / 57.215			47.200 / 47.215	
4th repair stage	56.950 / 56.965			46.950 / 46.965	

Permissible deviation of crankshaft journals and crankpins from true		0.005
Permissible conicity of crankshaft journals and crankpins		0.01
Permissible deviation of flywheel flange from true		0.02
Permissible axial runout of fitted bearing		0.02
Fillets	on crankshaft bearing journals	2.5 to 3.0
	on crankpins	3.0 to 3.5
Permissible deviation of crankshaft bearing journals from true when mounted in outer crankshaft bearing journals	journal II, IV	0.07
	journal III	0.10
Scleroscope hardness of crankshaft journals and crankpins		55-74
Permissible unbalance of crankshaft		15cmg

Special tool

Impact hardness tester		000 589 20 21 00

Note

When testing and reconditioning crankshafts, proceed in sequence of diagram shown below.

Diagram

*** Refer to section "Explanations concerning diagram".**

V = scrap.

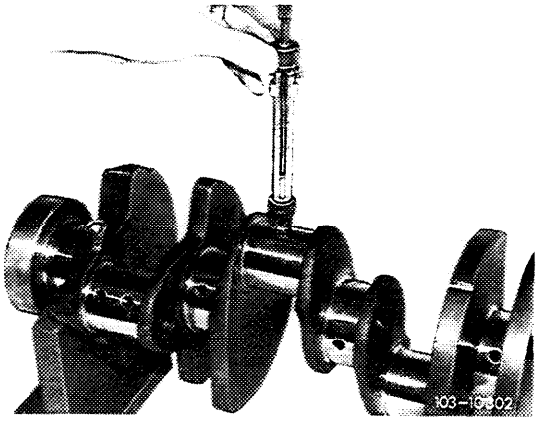
Visual checkup
Heavy damage?
yes
V
no
Crack test*
Cracks showing?
yes
V
no
Hardness test*
All bearing journals scleroscope hardness min. 60 on 2/3 of journal circumference
no
yes
Measure pin (journal) Dimensions in order?
no
yes
Lapping
Dimensional checkup Dimensions in order?
no
yes
Crankshaft, complete, balance, if possible
Check whether regrinding is still possible within last specified repair stage 4
no
V
no
V
yes
Hardening+
Journal or pin with hardened fillets
Induction hardening facilities available?
no
yes
yes
V
Induc-tion hardening
Journal or pin without hardened fillets
Induction or flame hardening
Check hardness by etching*
Relieve crankshaft at 80 °C/176 °F for 2 hours
Refer to crank-shaft, straighten
yes
Crankshaft, straighten
Crankshaft, grind
Crack test Cracks showing?
no
Refer to lapping

Explanations concerning diagram

Crack test

Clean crankshaft. Bearing journals should be free of oil and grease.
Magnetize crankshaft and apply fluorescent powder (fluxing).
A color penetration method may also be used (immersion in bath or using spray can).

Agent: Paint or fluorescent powder,
cleaning agent,
developer



Hardness test

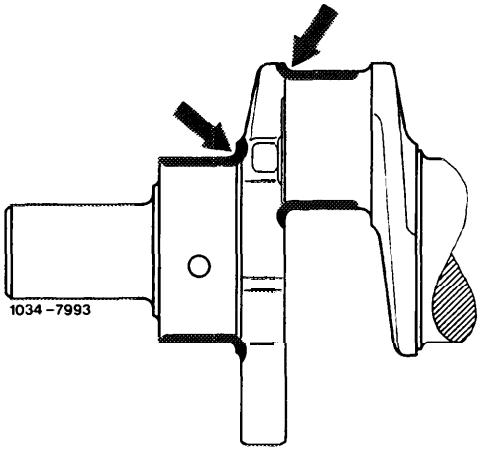
Test hardness with impact hardness tester (scleroscope hardness).

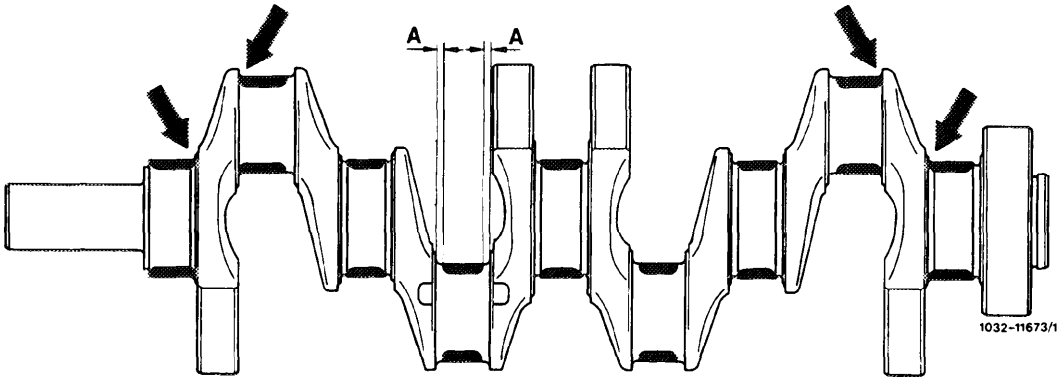
Minimum hardness of 55 should be available on 2/3 of journal (pin) circumference.

Hardening

Pins without hardened fillets can be inductance-hardened or flame-hardened. On the other hand, journals and pins with hardened fillets (arrows) should be inductance-hardened on principle. If this cannot be done, scrap crankshaft.

When hardening journals and pins without hardened fillets, the distance A between hardened runout and fillets radius (5-6 mm) must be maintained.





Checking the hardening results

For perfect hardening, check adjustment of hardening equipment by means of metallographic etching (grinding).

These tests can be made with test hardenings on scrapped crankshafts.

Check hardening by etching surface of journals or pins with a 2 % solution of alcoholic nitric acid (HNO_3).

No dark spots should appear on journal or pin surface.

Unhardened fillets will become dark.

Hardened fillets, on the other hand, should be as bright as the surface of pin or journal.

A journal or pin which has already passed metallographic inspection may be used for comparison.

Then carefully wash off nitric acid with alcohol.

Protection against corrosion

Crankshafts which are not immediately installed again should be lubricated with engine initial operation oil (SAE 30).

Data

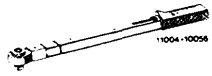
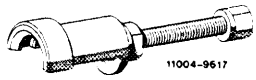
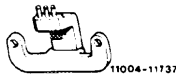
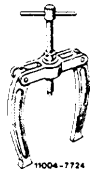
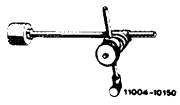
Crankshaft standard dimension and repair stages	Crankshaft bearing journal dia.	Fitted bearing Associated thickness of thrust washers	Crankshaft journal widths	Crankpin dia.	Crankpin width
Normal dimension	57.950 / 57.965	2.15	26.52 / 26.50	47.950 / 47.965	27.96 / 28.04
		2.20	26.62 / 26.60		
1st repair stage	57.700 / 57.715	2.25 or 2.35 or 2.40	26.72 / 26.70 or 26.92 / 26.90 or 27.02 / 27.00	47.700 / 47.715	up to 28.30
2nd repair stage	57.450 / 57.465			47.450 / 47.650	
3rd repair stage	57.200 / 57.215			47.200 / 47.215	
4th repair stage	56.950 / 56.965			46.950 / 46.965	

Basic bore and bearing play		Crankshaft bearings	Connecting rod bearings
Basic bore dia.		62.500 / 62.519	51.600 / 51.619
Basic bore width on fitted bearing		22.00 / 21.97	———
Connecting rod width		———	23.835 / 24.165
Permissible out-of-true of basic bore		0.01	
Permissible conicity of basic bore		0.01	
Bearing play, radial	when new	0.03 l-0.073 [1])	
	wear limit	0.08	
Bearing play, axial	when new	0.10-0.25	0.12-O-26
	wear limit	0.30	0.50

[1]) For radial clearance, try for mean value.

Bearing shells	Wall thickness crankshaft bearings	Width of bearing shells	Thickness of fitted bearing thrust washers	Wall thickness connecting rod bearings
Normal dimension	2.25	17.30-17.60	2.15 or 2.20	1.80
1st repair stage	2.37		2.25	1.92
2nd repair stage	2.50		or	2.05
3rd repair stage	2.62		2.35	2.17
4th repair stage	2.75		or	2.30
			2.40	

Tightening torques		Nm
Crankshaft bearing bolts		90
Connecting rod screws	initial torque	30 + 5
	angle of rotation torque	90–100°
Screw M 18 x 1.5 x 50 on crankshaft		370 + 40
Necked-down screws for flywheel or driven plate	Initial torque	30-40
	angle of rotation torque	90-l 00”

Special tools		
Torque wrench, singe-arm, with ratchet, 3/4'' square, 150-800 Nm		001 589 74 21 00
Torque wrench, single-arm, emitting signal, with plug-in ratchet, 1/2'' square, 25-130 Nm		001 589 66 21 00
Puller for crankshaft timing gear		601 589 07 33 00
Detent		601 589 02 40 00
Countersupport for internal puller		000589333300
Internal puller 14.5-18.5 mm for radial ball bearings		000589253300
Dial gauge holder for measuring end play		363589022100

Note

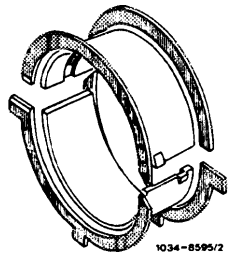
Engine removed and disassembled.

Main oil duct in cylinder crankcase open (01–130). Oil ducts in cylinder crankcase and in crankshaft carefully cleaned.

Check crankshaft for cracks, dimensional accuracy hardness and concentricity (93-318).

The 3rd crankshaft bearing is provided with thrust washers.

These thrust washers absorb the axial forces of crankshaft.

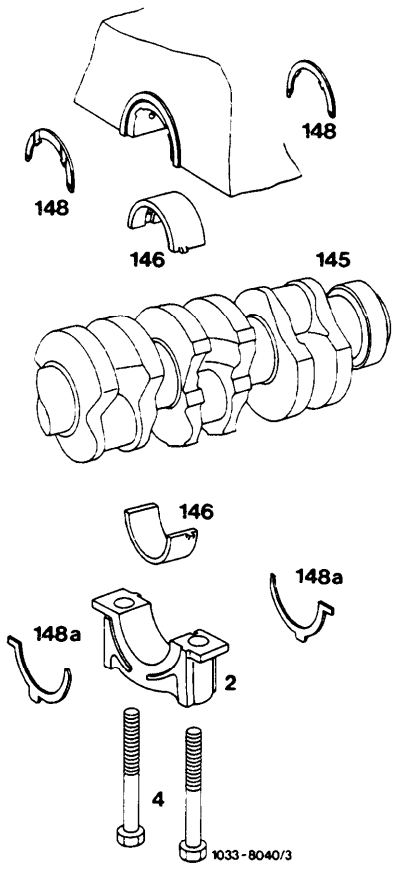


The thrust washers (148 and 148a) installed in cylinder crankcase and in bearing cap on both sides are of different shape.

As a torsion lock and to prevent assembly faults, the thrust washers in bearing cap are provided with two holding lugs, of which the outer one is installed off center.

When reconditioning crankshafts, regrind width of fitted bearing journals to one of the dimensions shown in Table (section "Data").

Associate thrust washers to respective journal or pin widths (Table).



2 Bearing cap
4 Screws M 12x60
145 Crankshaft
146 Bearing shell
148 Upper thrust washer
148a Lower thrust washer

Install thrust washers of the same thickness on both sides on principle.

Regrinding of thrust washers is not permitted.

As replacement parts, thrust washers are available in sets only. One set comprises an upper and a lower thrust washer (148 and 148a).

Thrust washer sets

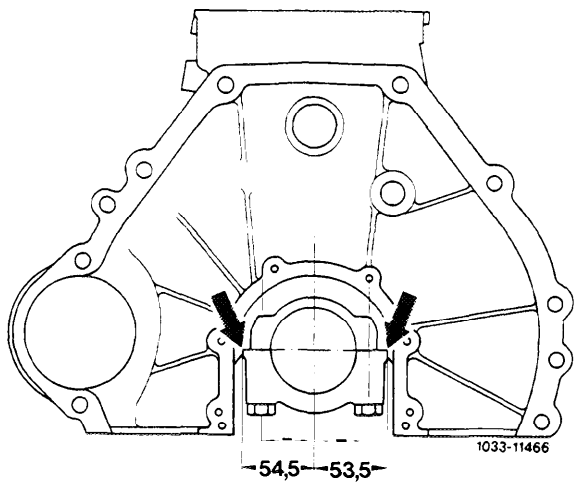
Thickness in mm	Set part no.
2.15	601 030 00 62
2.20	601 030 01 62
2.25	601 0300262
2.35	6010300362
2.40	601 030 04 62

Association of crankshaft bearings, installation of crankshaft

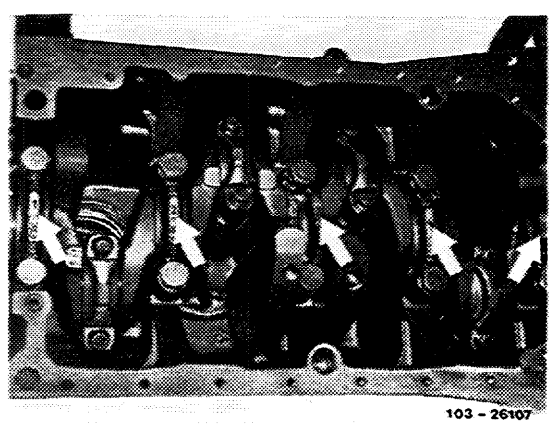
1 Install crankshaft bearing cap.

Note: All bearing caps are fitted laterally into crankcase (arrows) and are fastened with 2 screws M 12 x 60 each.

The pilot fit (arrows) is offset from center by 0.5 mm, so that the bearing caps can be mounted in one position only.



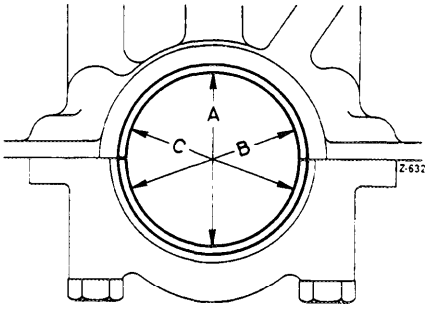
The bearing caps are additionally identified from the front to the rear with the code numbers 1, 2, 3, 4 and 5 (arrows), and should not be mixed up.



2 Lubricate screws for crankshaft bearing caps and tighten to 90 Nm.

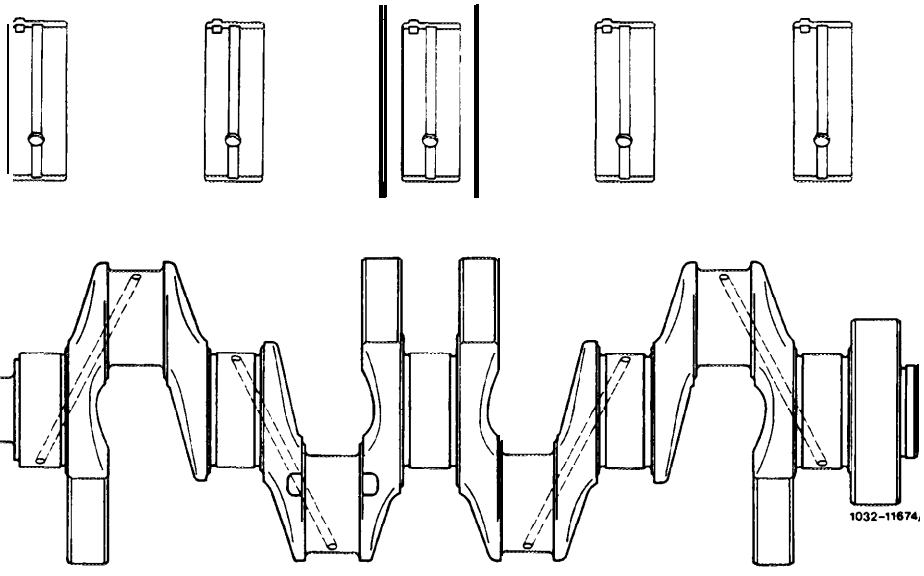
3 Measure basic bore in direction A, B and C on two levels (conicity).

If the specified value of a basic bore is exceeded, touch up bearing cap at its parting surface on a surface plate up to max. 0.02 mm.

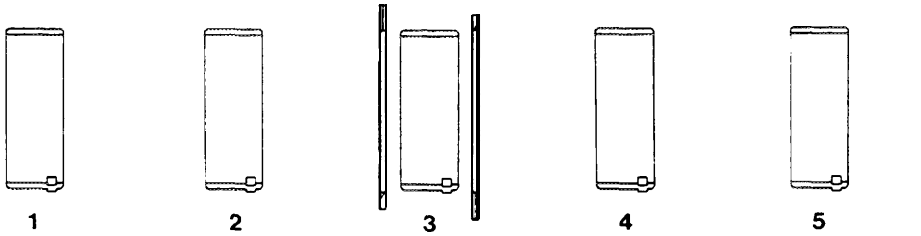


4 Insert crankshaft bearing shells, mount bearing caps, tighten screws to 90 Nm.

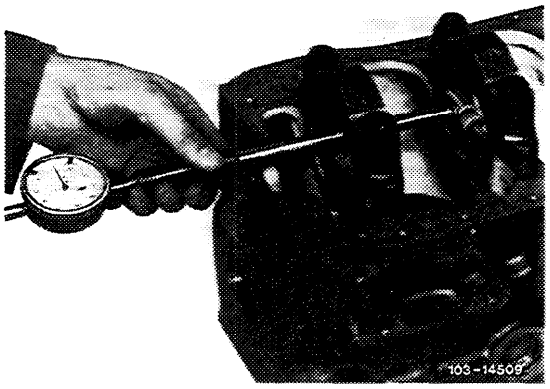
Housings



Caps

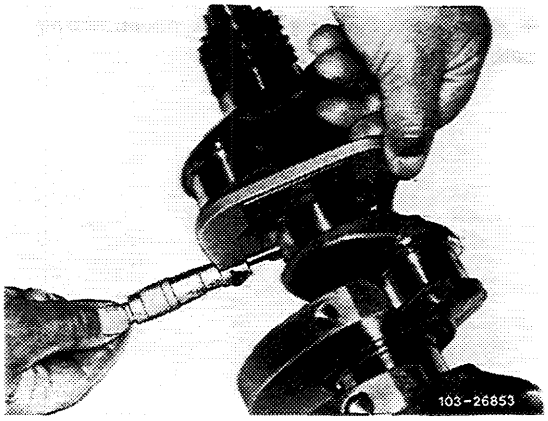


5 Measure bearing dia. and write down.

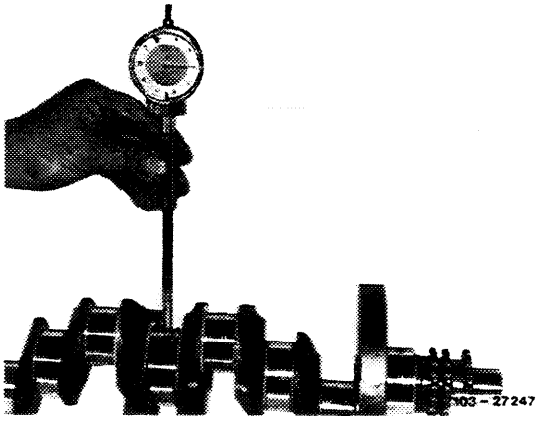


6 Measure crankshaft bearing journals, find crankshaft bearing radial play.

Note: The bearing play can be corrected by exchanging bearing shells, while trying for mean value of specified bearing play. Crankshaft bearing shells without color code are thicker than those with blue color code, while taking into account that the thickness of walls without and with color code may overlap.



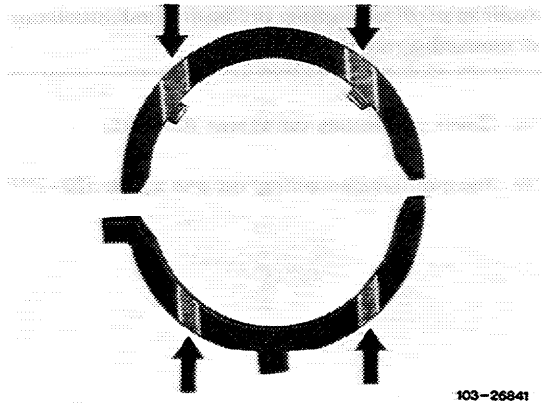
7 Measure width of fitted bearing journal and associate pertinent thrust washers (refer to Table, section Data).

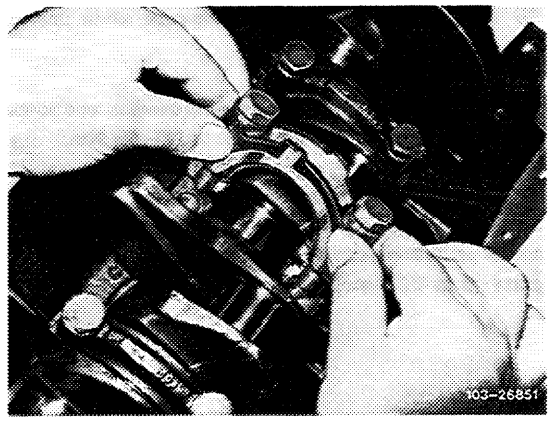


8 Lubricate bearing shells and crankshaft with engine oil and install crankshaft.

9 **Provide thrust washers with oil and** slip into grooves on fitted bearing (crankcase).

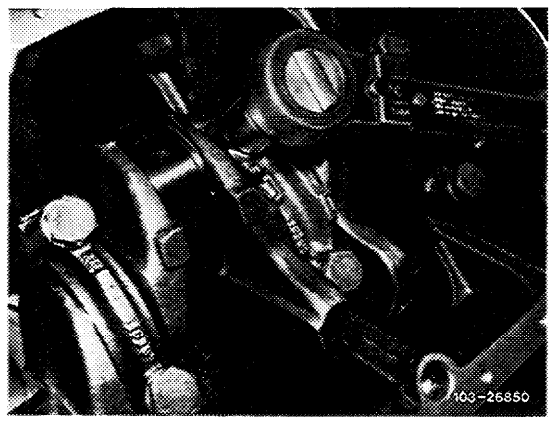
Attention!
Make sure that the two oil grooves (arrows) in thrust washers are pointing toward crankshaft webs.





10 Mount crankshaft bearing caps.

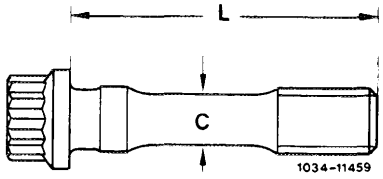
11 **Tighten bearing caps to 90 Nm.**



12 Measure crankshaft end play.

13 Rotate crankshaft manually and check for easy running.

Association of connecting rod bearing and installation of connecting rod



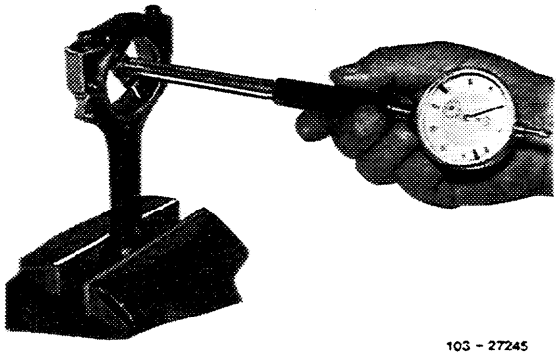
14 Check connecting rod screws (03-310).

15 Recondition connecting rod and square (03–313).

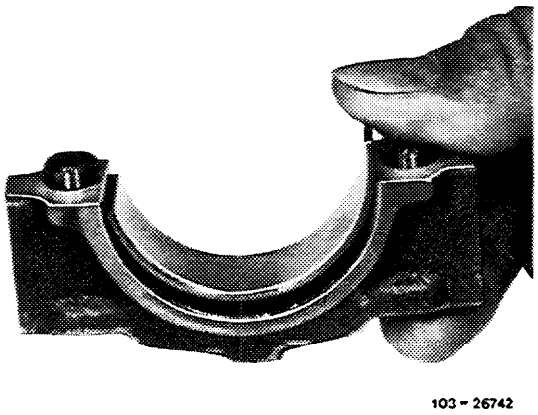
16 Mount connecting rod bearing caps, while paying attention to identification_

Lubricate connecting rod screws on threads and screw head contact surface and tighten to 30-40 Nm.

17 Measure basic bore in two directions. If one basic bore exceeds the specified value or if it is conical, touch up bearing cap at its parting surface on a surface plate up to 0.02 mm.



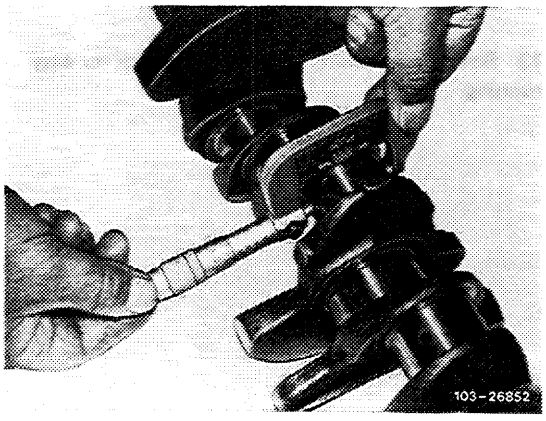
18 Insert connecting rod bearing shells, mount connecting rod bearing caps together with bearing shells and tighten connecting rod nuts to 30-35 Nm.



19 Measure bearing dia. and write down.

20 Measure crankpins, find connecting rod bearing radial play.

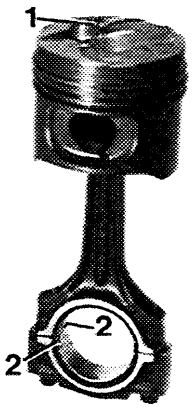
Note: The bearing play can be corrected by changing bearing shells, trying for medium value of specified bearing play. Crankshaft bearing shells without color coding are thicker than those with blue color coding, while taking into account that the thickness of wails without and with color coding may overlap.



21 Attach piston to connecting rod (03–316).

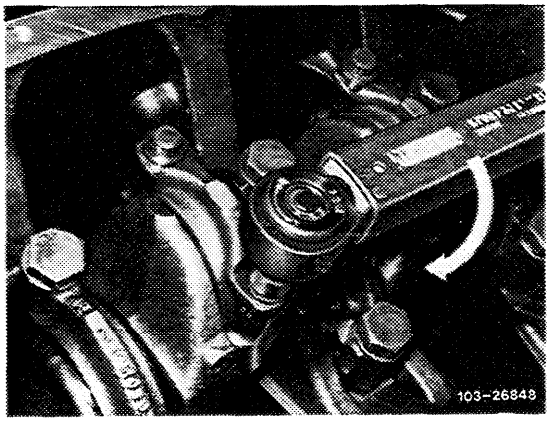
22 Provide bearing shells, crankshaft, pistons and cylinder walls with engine oil, install connecting rod with piston (03–316).

Pay attention to identification.



103-26983

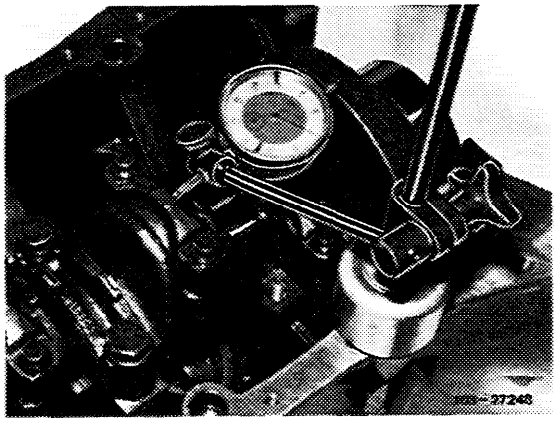
23 Tighten connecting rod screws to 30 + 5 Nm initial torque and 90–100° angle of rotation torque.



24 Measure connecting rod bearing end play, while displacing connecting rod directly at piston pin. Check clearance of connecting rods in relation to crankshaft.

Attention!
Disassemble oil pump and clean, renew, if required. Renew oil pressure relief valve. Disassemble oil filter and clean.

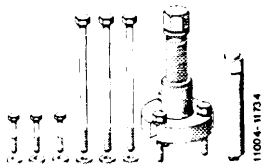
Install initial operation oil filter element. Change engine oil and oil filter element after 1000-1500 km



03-324 Replacing front crankshaft radial sealing ring

Tightening torques	Nm
Screw M 18 x 1.5 x 50 on crankshaft	370 + 40
Screws M 8 x 12 pulley to hub	25

Special tools

Torque wrench, single-arm, with ratchet, 3/4'' square, 150-800 Nm		001 5897421 00
Puller for hub		601 589 08 33 00
Detent		601589024000
Sleeve for pushing in radial sealing ring, front		601 589031400

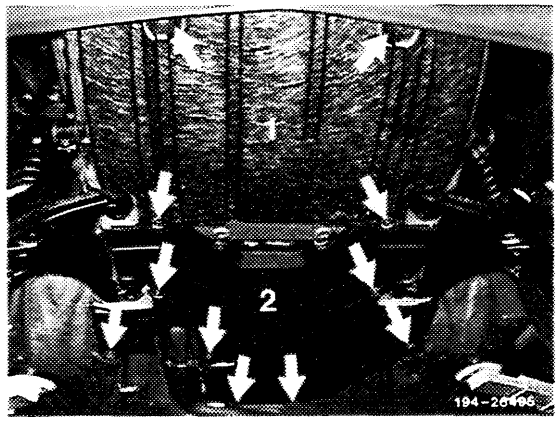
Conventional tool

Adapter 3/4'' square socket to 1/2'' square head	e.g. Hazet, D-5630 Remscheid order no. 1058 R-I

Removal

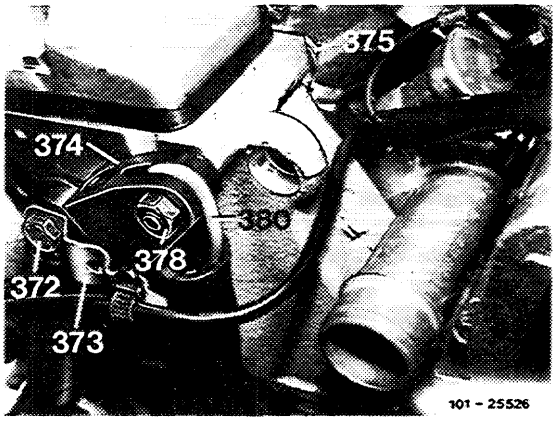
1 Remove noise capsule.

2 Remove radiator (20-420).

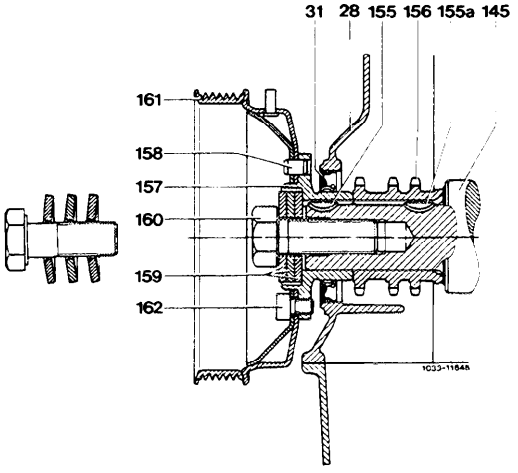


3 Slacken V-belt and remove. Unscrew flange nut (378) for this purpose. Insert a mandrel into spring tensioning lever (374) and relieve hex. screw (375) in relation to draw spring (380) until spring can be pushed back in direction of intake manifold.

Release spring tensioning lever and remove V-belt.



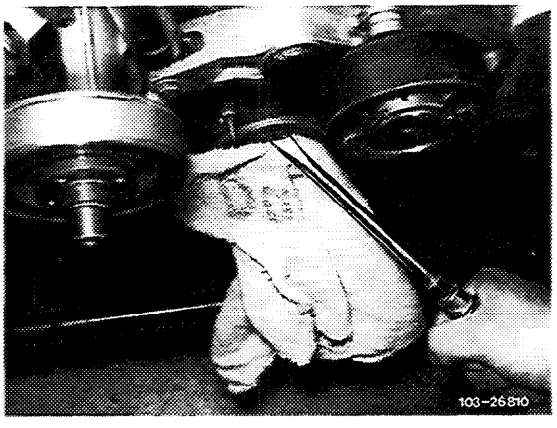
4 **Unscrew pulley (161) and pull off flange (157) (03-341).**



28 Timing housing cover
31 Radial sealing ring
145 Crankshaft
155 Woodruff key, hub
155a Woodruff key, sprocket
156 Sprocket
157 Hub
158 Cylindrical pin
159 Cup spring
160 Screw M 18 x 1.5 x 50
161 Pulley
162 Combination screw M 8 x 12

5 Push out radial sealing ring by means of a screwdriver. Make sure that crankshaft journal and mounting bore are not damaged.

6 Check hub (157) for score marks of radial sealing ring, renew hub, if required.

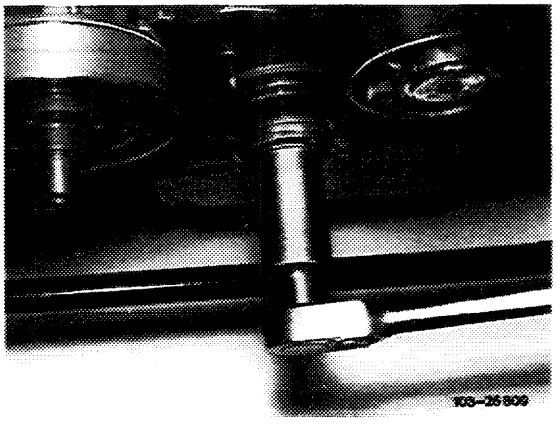


Installation

7 Deburr mounting bore for radial sealing ring and clean.

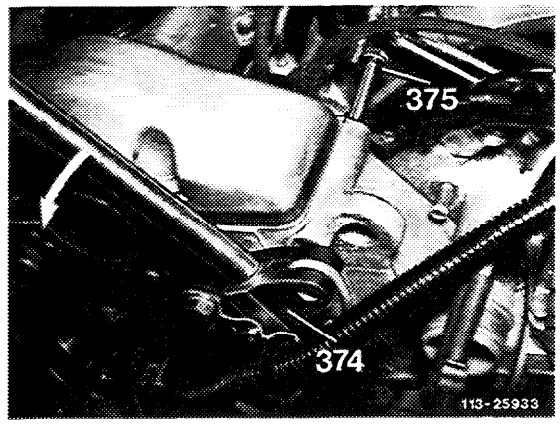
8 Moisten new radial sealing ring on sealing lip with oil and insert with inserting tool.

Attention!
The radial sealing ring should be accurately square in relation to crankshaft journal, since otherwise no perfect sealing will be obtained.



9 Install hub and pulley (03–341).

10 Mount V-belt and engage spring tensioning lever. For this purpose, swivel spring tensioning lever (374) with a mandrel against draw spring to the left until screw (375) can be slipped through spring tensioning lever. Position collar nut and tighten.

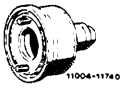


11 Install radiator (20–420).

12 Install **noise capsule.**

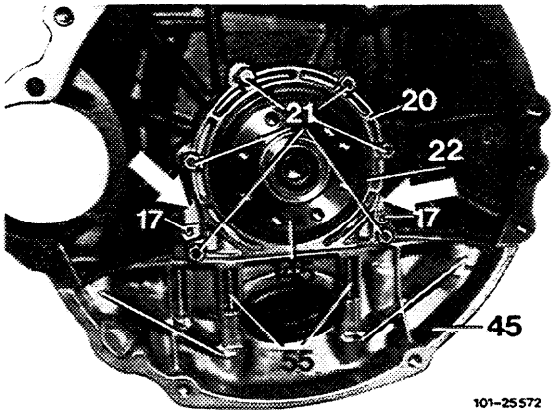
03-327 Replacing rear crankshaft radial sealing ring

Tightening torques		Nm
Necked-down screw for flywheel or driven plate	initial torque	30 + 10
	angle of rotation torque	90-l 00”

Special tools		
Detent	11004-11737	601589024000
Installation tool for rear crankshaft radial sealing ring	 11004-11740	601589034300

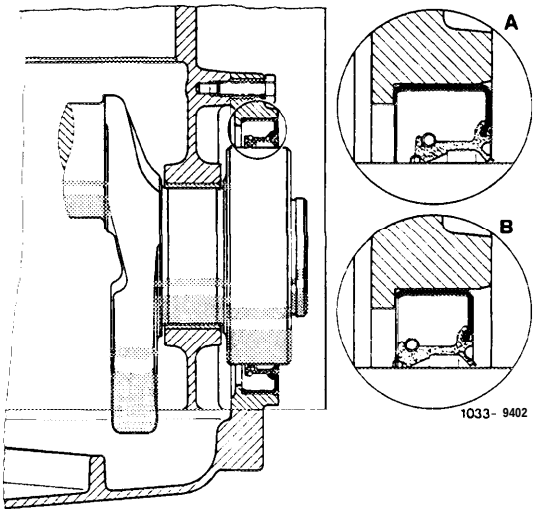
Note

The radial sealing ring (22) is seated in an end cover screwed to cylinder crankcase and oil pan and located by means of 2 clamping sleeves (17).



101-25572

The sealing lip of repair radial sealing ring is offset by 3 mm in inward direction, so that it cannot run in a groove which may have been generated by series-radial sealing ring on crankshaft flange.



1033- 9402

A Radial sealing ring (series)
B Repair radial sealing ring

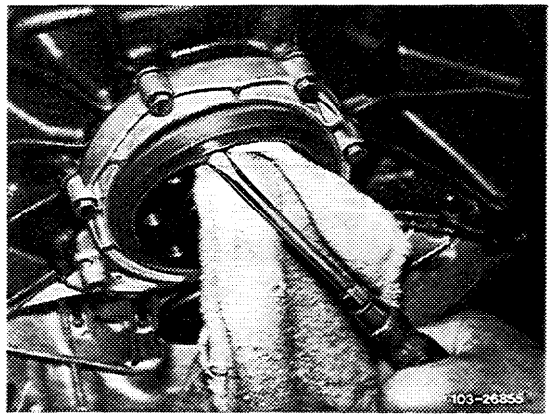
Renewing

1 **Remove transmission (26-020 or 27–600).**

2 **Remove flywheel or driven plate (03–410).**

3 **Push radial sealing ring out of end cover by means of a screwdriver.**

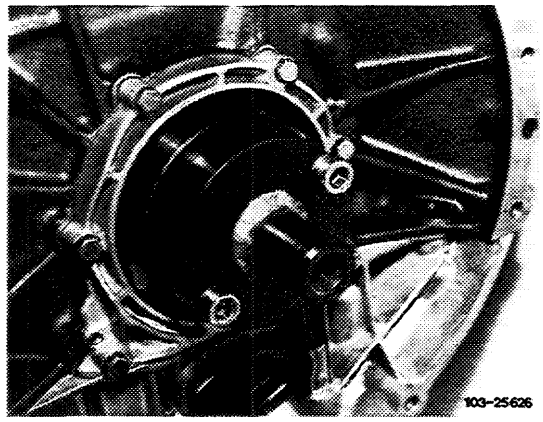
Make sure that the crankshaft flange and the end cover are not damaged. Cover crankshaft flange with a rag.



4 **Check running surface for radial sealing ring on crankshaft flange for damage.**

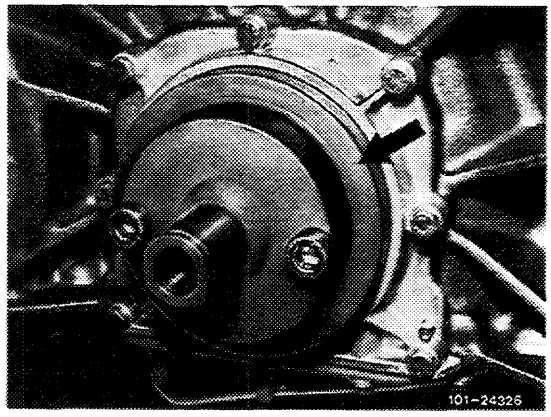
5 **Clean mounting bore for radial sealing ring and deburr, if required.**

6 **Screw inner part of installation tool to crankshaft flange.**



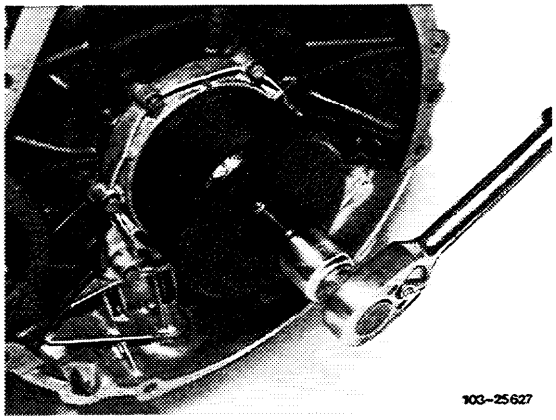
7 **Fill new radial sealing ring between sealing and dust lip with 1 g or 1 cc longterm grease. Do not fill in more oil, since otherwise the presence of leaks might be simulated.**

8 **Slip radial sealing ring (arrow) over inner part of installation tool.**



9 Push radial sealing ring up to stop into end cover by means of outer part of installation tool.

Attention!
Radial sealing ring should be seated accurately square in end cover for perfect sealing.



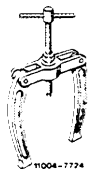
10 install flywheel or driven plate (03-410).

11 Check for leaks with engine running.

12 install transmission (26-020 or 27–600).

03-330 Removal and installation of radial ball bearing in crankshaft

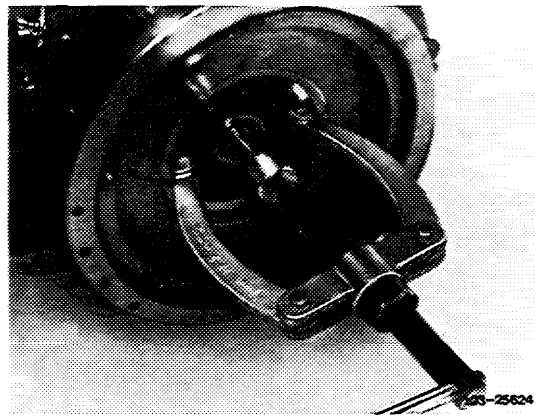
Special tools

Countersupport for internal puller		000589333300
Internal puller 14.5-18.5 mm		000589253300

Removal

1 Remove transmission (26–020 or 27-600).

2 Pull ball bearing out of crankshaft together with countersupport and internal puller.



Installation

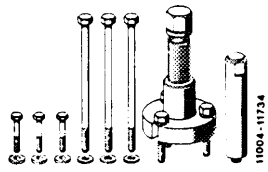
3 Coat new ball bearing with glue "Loctite 241", part no. 002 989 94 71 and knock into crankshaft on outer race by means of a suitable mandrel.

4 Install transmission (26-020 or 27–600).

03–341 Removal and installation of crankshaft pulley and hub

Tightening torques	Nm
Screw M 18 x 1.5 x 50 to crankshaft	370 + 40
Screws M 8 x 12 crankshaft pulley to hub	25

Special tools

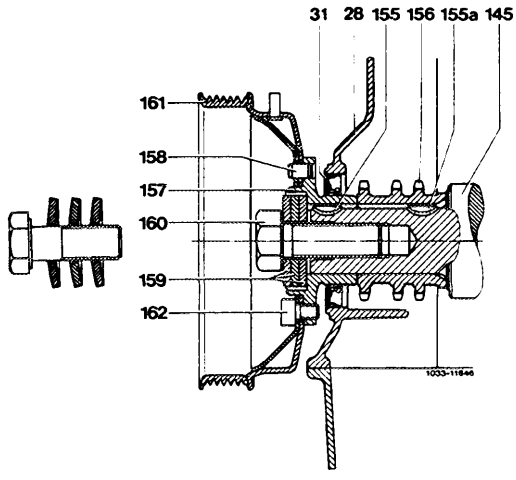
Torque wrench, single-arm, with ratchet, 3/4'' square, 150-800 Nm		001 5897421 00
Detent		601 589 02 40 00
Puller for hub		601589083300

Conventional tool

Adapter 3/4'' square socket to 1/2'' square head	e.g. Hazet, D-5630 Remscheid order no. 1058 R-l

Note

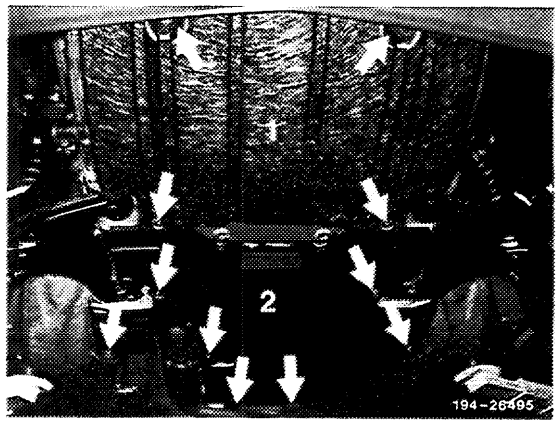
Engines 601 have no vibration damper and no balancing disk.



28 Timing housing cover
31 Radial sealing ring
145 Crankshaft
155 Woodruff key for hub
155a Woodruff key for sprocket
156 Sprocket
157 Hub
158 Cylindrical pin
159 Cup spring
160 Screw M 18 x 1.5 x 50
161 Crankshaft pulley
162 Combination screw M 8 x 12

Removal

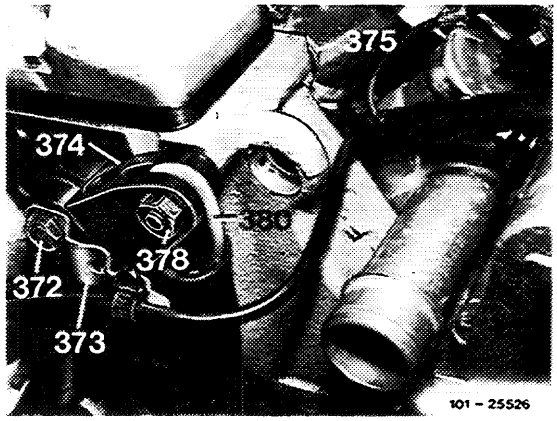
Remove noise capsule below.



2 Remove radiator (20–420).

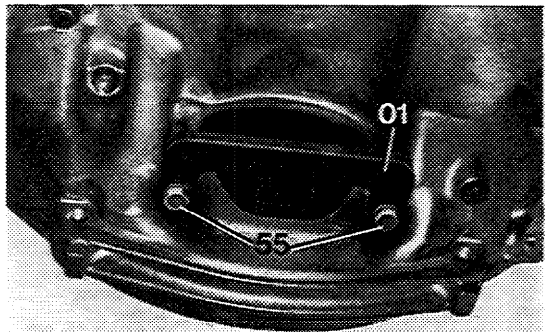
3 Slacken V-belt and remove. For this purpose, unscrew collar nut (378). Insert a mandrel into spring tensioning lever (374) and releave hex. screw (375) opposite to draw spring (380) until spring can be pushed back in direction of intake manifold.

Release spring tensioning lever and remove V-belt.



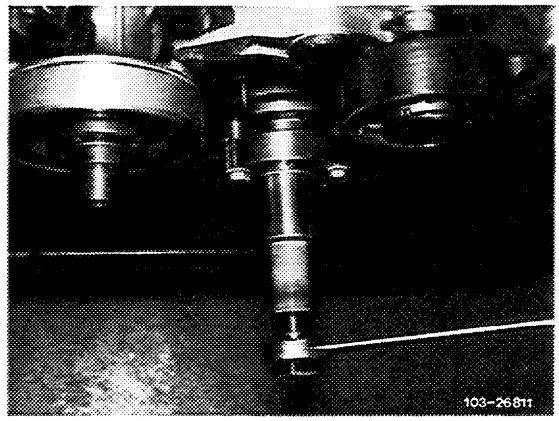
4 Remove crankshaft pulley.

5 Unscrew screw (160) on crankshaft. For this purpose, fasten detent, part no. 601 589 02 40 00, to oil pan.



6 Pull hub (157) from crankshaft journal.

Pull off hard-to-move hubs with puller.

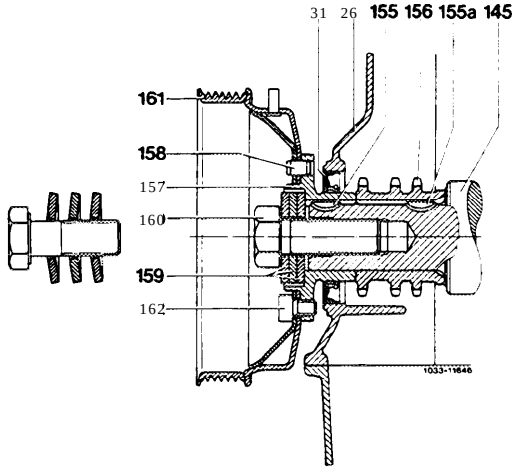


Installation

7 Slip hub (157) on crankshaft journal and tighten screw (160) to 370 + 40 Nm.

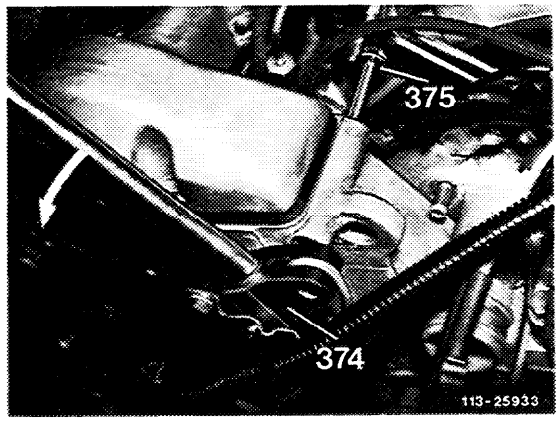
Make sure that woodruff key (155) and groove are in alignment.

Note: Install the three cup springs (159) with crown toward screw head.



8 Mount V-belt pulley, while paying attention to centering by means of cylindrical pin (158).

9 Mount V-belt and engage spring tensioning lever. For this purpose, swivel spring tensioning lever (374) with a mandrel against draw spring to the left until screw (375) can be slipped through spring tensioning lever. Position collar nut and tighten.



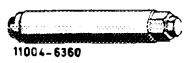
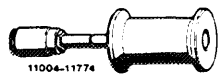
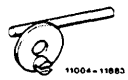
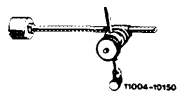
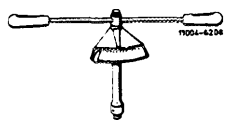
10 Install radiator (20-420).

11 Install noise capsule.

03–345 Checking and correcting adjustment of TDC transmitter

Tightening torques	Nm
Screws for cylinder head cover	10
Coupling nuts for injection lines (reference value)	1 O-20
Prechamber in cylinder head (threaded ring)	100 ± 10
Nozzle holder in prechamber	70 + 10

Special tools

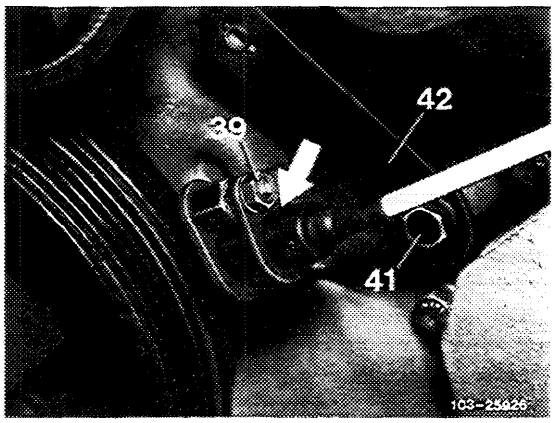
Box end wrench element, open, 14 mm, 1/4" drive, for coupling nut of injection line	11004-105201	000 589 77 03 00
Wrench element for threaded ring of prechamber	 11004-6360	615589000700
Socket wrench element 27 mm, 1/2" square	11004-6193	001 589 65 09 00
Impact puller for prechamber	 11004-11774	601 589 06 33 00
Locating device for holder of TDC transmitter	 11004-11883	601 589 06 21 00
Measuring instrument for TDC and 20° after TDC	11004-11884	601 589 07 21 00
Dial gauge holder	 11004-10150	3635890221 00
Torque wrench, double-arm, 3/8" square, 8-32 Nm	 11004-6206	001 589 51 21 00

Conventional tool

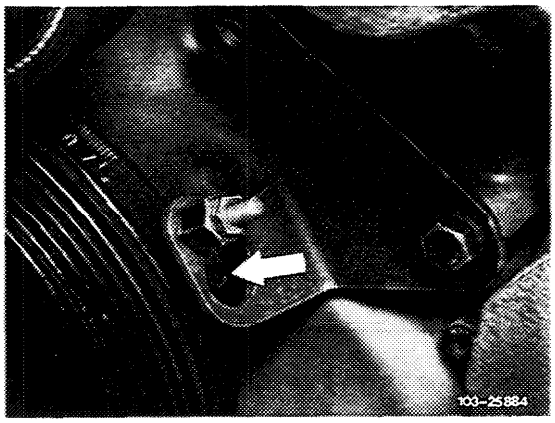
Dial gauge A 1 DIN 878	e.g. Mahr, D-7300 Esslingen order no. 810

Note

The TDC-transmitter with holder is fastened to timing housing cover (arrow).



The pin in crankshaft pulley must be accurately under TDC transmitter (arrow) in crankshaft position 20" after TDC.



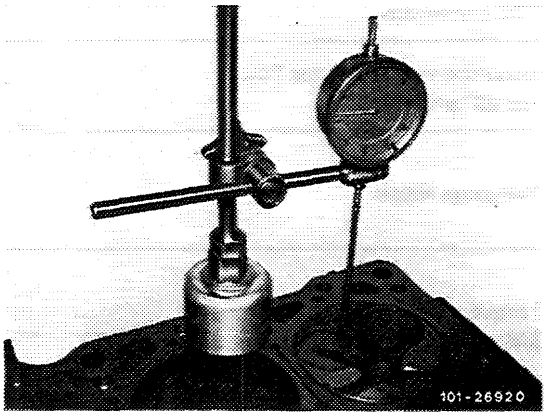
Adjustment of adjusting slide must be checked and corrected, if required:

a) When renewing adjusting slide.

b) When renewing crankshaft with hub or crankshaft pulley.

c) When completing partial engines.

With cylinder head removed, the measuring pin of the dial gauge can be set directly on piston crown. For this purpose, place magnetic dial gauge holder on cylinder crankcase parting surface.

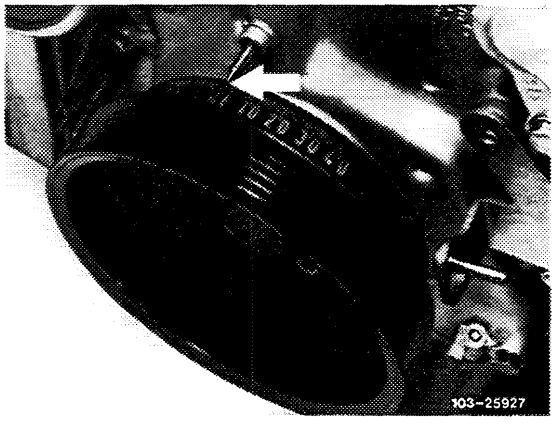


Checking

1 Remove radiator (20–420).

2 Remove cylinder head cover.

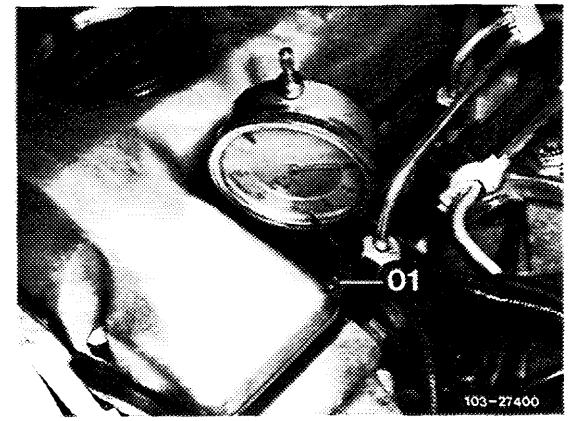
3 Set piston of 1st cylinder to ignition TDC of 1st cylinder.



4 Remove prechamber of 1st cylinder (01–417).

5 Screw measuring instrument into prechamber duct.

6 Place dial gauge at 2 mm preload on test mandrel.



7 Slowly rotate crankshaft in direction of rotation of engine until large needle of dial gauge stops (TDC position).

8 Loosen dial gauge and place measuring arm under 5 mm preload into test mandrel. Turn dial gauge scale until large needle points to zero.

9 Slowly turn crankshaft in direction of rotation of engine until on engine 601.911 the dial gauge has moved back by 3.22 mm and on engine 601.921 by 3.65 mm.

10 Place locating device into adjusting slide.

Pin in crankshaft pulley must engage in groove of locating device.

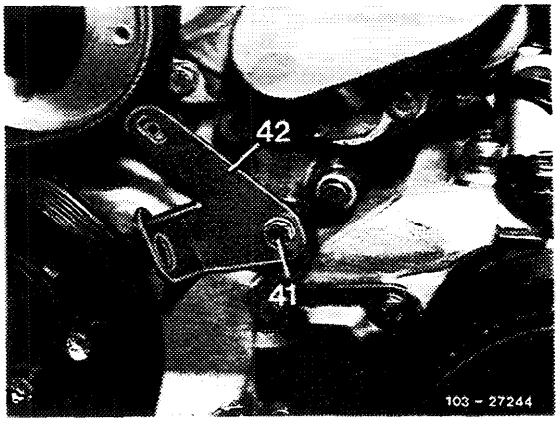
If pin is not engaging, correct position of adjusting slide.

Correcting

11 Loosen adjusting slide (42) on screw (41) and displace until pin in pulley engages in groove of locating device.

12 Screw down adjusting slide.

13 Remove dial gauge and measuring instrument.



14 Install prechamber (01–417).

15 Install valve cover.

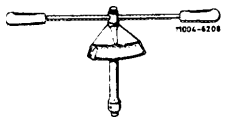
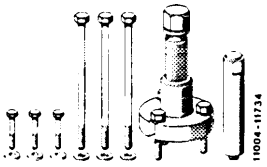
16 Install radiator.

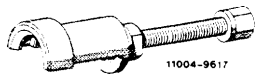
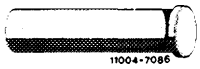
17 Run engine, check for leaks.

03-350 Removal and installation of crankshaft timing gear

Tightening torques		Nm
Screw M 18 x 1.5 x 50 to crankshaft		370 + 40
Screws for cylinder head cover		10
Screws M 8 x 12 for crankshaft pulley to hub		25
Oil drain plug to oil pan		30
Oil pan to cylinder crankcase	M 6	10
	M 8	25
Central screw for fan on coolant pump		25
Adjusting screw for front engine stop		130
Screws for engine carrier to engine mount		35 + 10
Cylinder head bolts M 8		25
Screws for timing housing cover	M 6	10
	M 8	25

Special tools

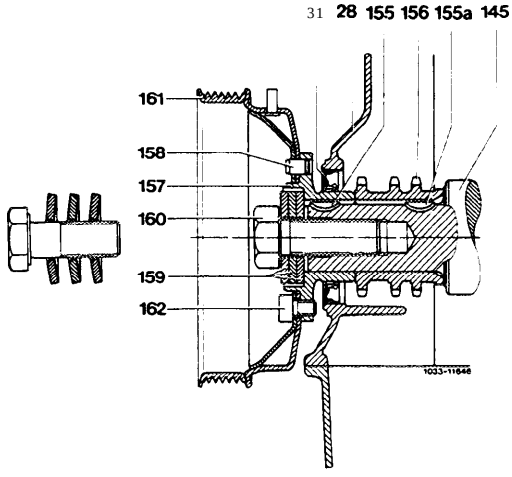
Torque wrench, double-arm, 1/4'' square, 8-32 Nm		001 589 51 21 00
Torque wrench, single-arm, emitting signal, with plug-in ratchet, 1/2'' square, 40-200 Nm		001 589 67 21 00
Torque wrench, single-arm, with ratchet, 3/4'' square, 150-800 Nm		001 589 74 21 00
Puller for hub		601 589 08 33 00

Puller for crankshaft timing gear		601 589 07 33 00
Knocking-in mandrel for crankshaft timing gear		116589071500
Screwdriver with tommy handle for hex. socket screws 6 mm, 440 mm long		116589030700

Conventional tool

Adapter 3/4" square socket to 1/2" square head	e.g. Hazet, D-5630 Remscheid order no. 1058 R-l

Layout crankshaft front



28 Timing housing cover
31 Radial sealing ring
145 Crankshaft
155 Woodruff key, hub
155a Woodruff key, sprocket
156 Sprocket
157 Hub
158 Cylindrical pin
159 Cup spring
160 Screw M 18x 1.5 x 50
161 Crankshaft pulley
162 Combination screw M 8 x 12

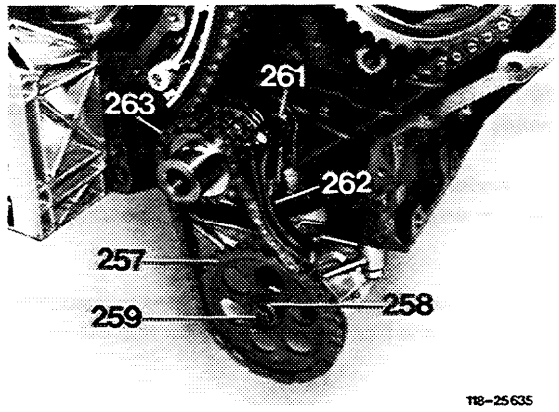
Removal

1 Remove timing housing cover (01-210).

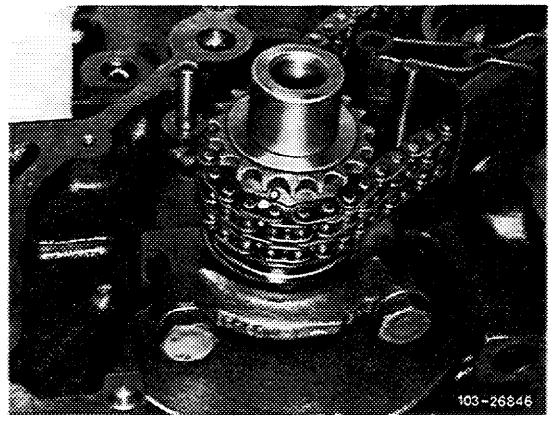
2 Pull off clamp (262) and torsion spring (261).

3 Unscrew fastening screw (259) and remove oil pump sprocket (257).

4 Remove chain for oil pump drive.

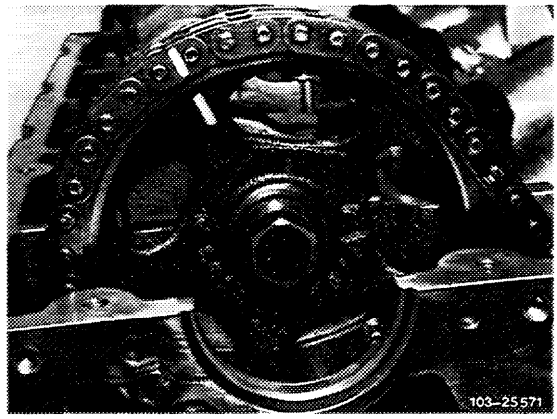


5 Mark timing chain and crankshaft timing gear in relation to each other.



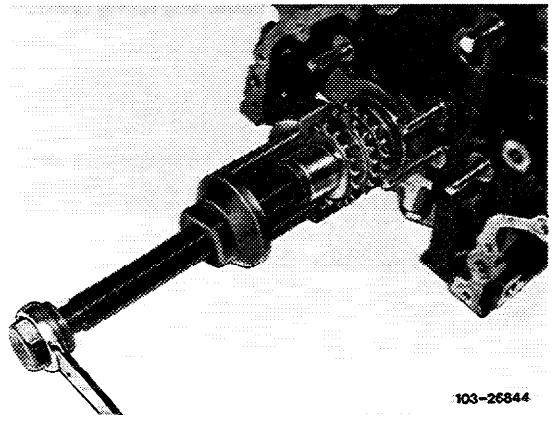
6 Mark timing chain and camshaft timing gear in relation to each other

7 Remove camshaft timing gear and let timing chain sag.



8 Pull off crankshaft timing gear with puller.

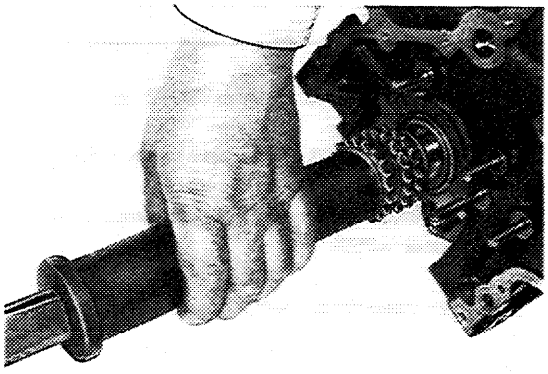
9 Check woodruff key in crankshaft for condition and renew, if required.



10 Transfer color mark from old to new crankshaft timing gear.

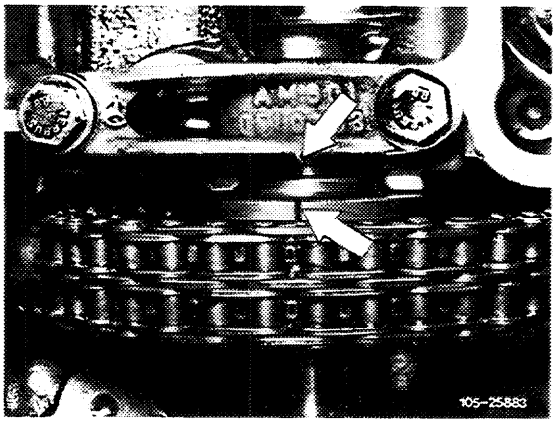
11 Knock crankshaft timing gear with knocking-in mandrel on crankshaft. Pay attention to woodruff key.

Note: For better location when knocking in crankshaft timing gear, the front woodruff key for hub can be inserted.



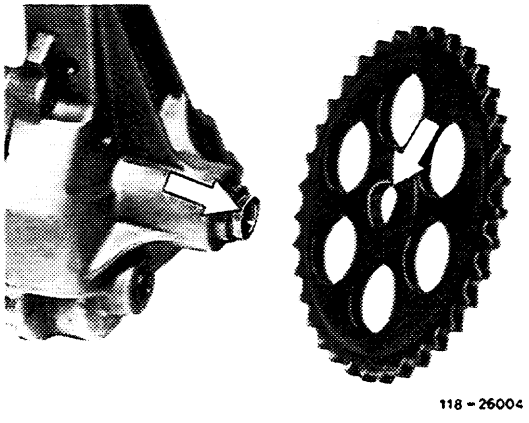
12 Mount camshaft timing gear and timing chain, paying attention to marks.

13 Keep turning crankshaft and check adjusting marks at TDC position of engine (arrows).

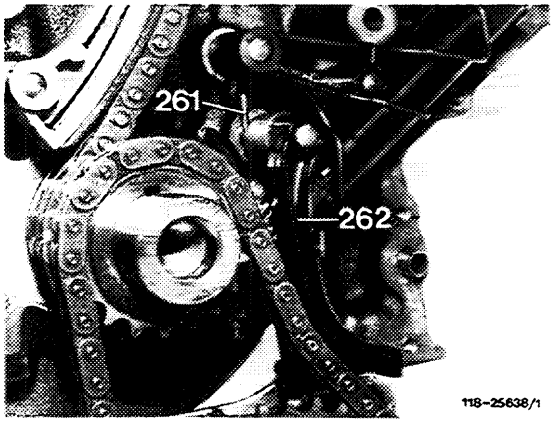


14 Mount chain for oil pump drive together with oil pump sprocket.

Note: Mount sprocket in such a manner that its crown is pointing toward oil pump and the three contact surfaces on the oil pump shaft coincide with those on the sprocket (arrows).



15 Install clamp (262) and tensioning spring (261).



16 Install timing housing cover (01–210).

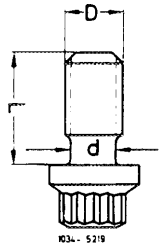
17 For further installation proceed vice versa.

18 Run engine and check for leaks.

03-410 Removal and installation of flywheel and driven plate

Necked-down screw

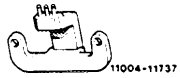
		manual transmission	automatic transmission
Part no.		1020320071	601 03201 71
Thread dia. D		M 10 x 1	
Necked-down dia. d	when new	8.5–0.2	
	min. dia.	8.1	
Length L	when new	22 ± 0.2	26 ± 0.2
	max. length	22.5	26.5



Tightening torque

Initial torque	30 + 10 Nm
Angle of rotation torque	90–100"

Special tools

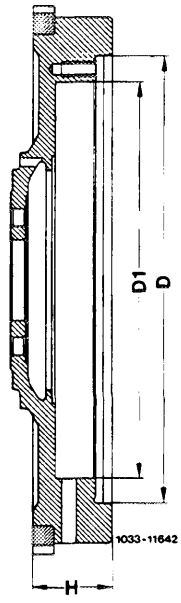
Detent	 11004-11737	601 589 02 40 00
Torque wrench, single-arm, emitting signal, with plug-in ratchet, 1/2'' square, 25-l 30 Nm	11004-10056	001 589 66 21 00

Note

Weight and dimensions of flywheels of engines with manual transmission are similar.

Flywheels and driven plates of engines with automatic transmissions are identical on all angines.

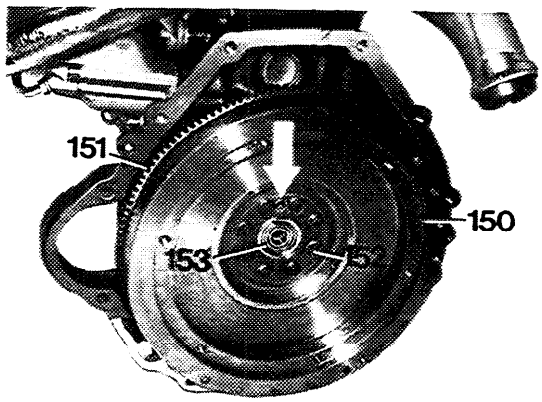
Flywheels can be replaced without static or dynamic balancing.



Engine 601

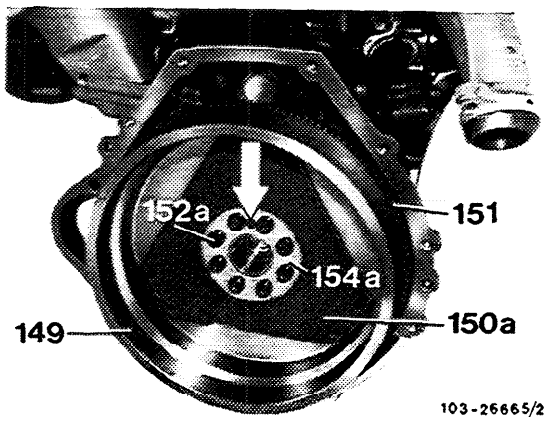
D 254.5 mm
D1 223 mm
H 57 m m

Fasten flywheel and driven plate to crankshaft in such a manner that the unused bores (arrow) on flywheel or on driven plate and spacing washer are in alignment with unused bore on crankshaft flange.



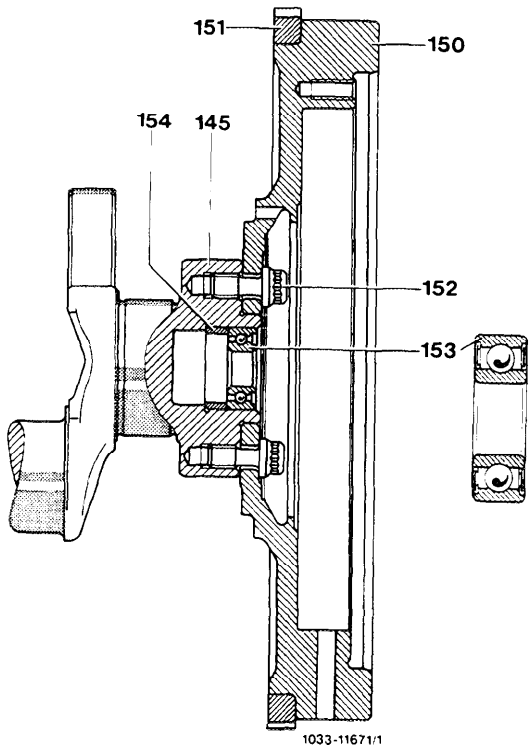
Vehicles with manual transmission

103-26328



Vehicles with automatic transmission

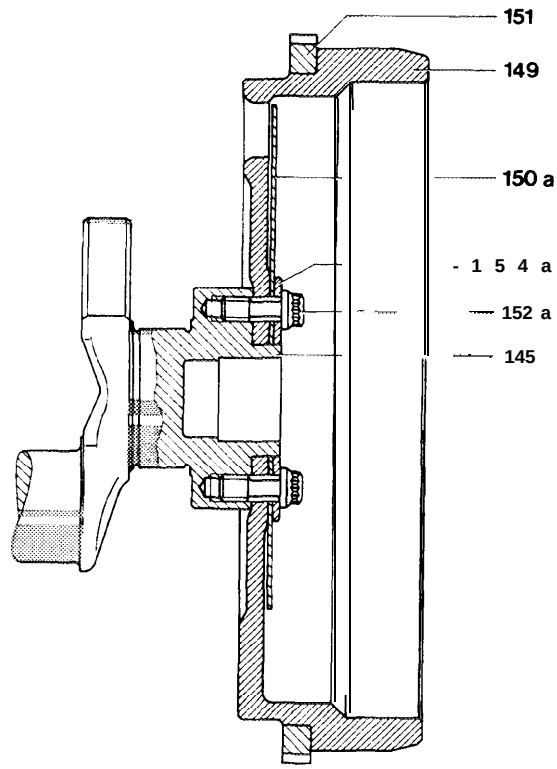
103-26665/2



1033-11671/1

Layout of flywheel for manual transmission

145 Crankshaft
150 Flywheel
151 Ring gear
152 Necked-down-screw
153 Ball bearing
154 Spacing ring



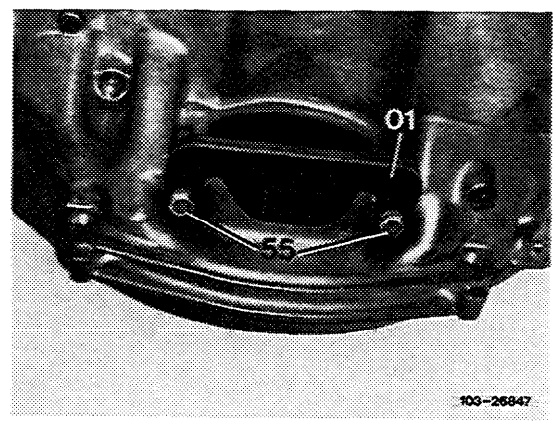
Layout of flywheel and driven plate for automatic transmission

145 Crankshaft
150a Driven plate
152a Necked-down screw
154a Spacing washer

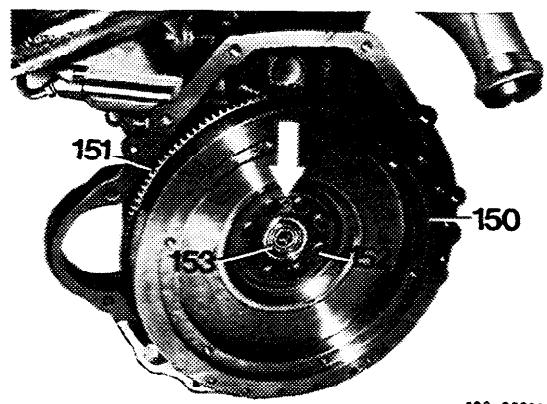
Removal

1 Remove **transmission (26-020 or 27–600).**

2 Fasten detent (arrow) to oil pan below.



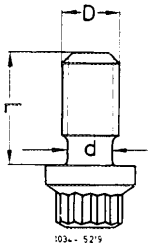
3 Unscrew necked-down screws (152) and remove flywheel, driven plate and spacing washer.



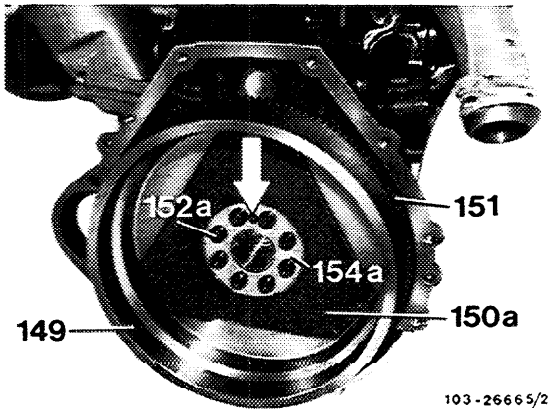
Flywheel manual transmission

4 Measure necked-down dia. of necked-down screws.

If minimum dia. is attained, install new necked-down screws.



5 Position flywheel, driven plate and spacing washer on crankshaft journal in such a manner that the bores (arrow) are in alignment.



6 Screw in necked-down screws and tighten to 30 Nm initial torque and 90–100° angle of rotation torque.

03-420 Refinishing of flywheel

Data		
Engine		601
Distance a		22.4-22.6
Distance b	when new	16.6
	during repairs	up to
Permissible deviation from axial runout on clutch surface or clutch flange-on surface		0.05 mm

Note

Flywheels for manual transmissions which are showing burnt spots, score marks or cracks on clutch surface, must be refinished by precision turning.

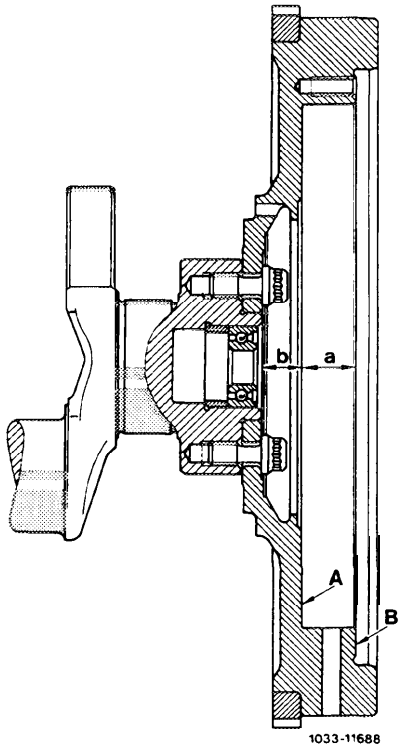
If score marks or cracks are deeper than the max. permissible material allowance, replace flywheel.

If the clutch surface A is refinished, also refinish fastening surface B by the same dimension to maintain distance a.

In the event of repairs, do not machine below dimension b.

For refinishing, clamp flywheel well, so that the permissible axial runout of 0.05 mm is not exceeded.

No cavities and chatter marks should be seen on clutch surface after refinishing.



03-430 Renewing ring gear of flywheel

Data	
Axial runout on ring gear	max. 0.4
Centering flange dia. for ring gear	275.00-275.05
Shrinking-on temperature	220 °C
Annealing color	yellow

Conventional accessory

Temperature measuring chalk color no. 2815/220 (white) Thermochrom	e.g. AW Faber-Castell, D-8504 Stein bei Nürnberg

Note

The ring gear is hardened. To protect hardness, the temperature for heating up ring gear should not exceed 220 °C at any point. This can be done reliably **only** by **means of a hot plate or a heating oven.**

An open flame may be used as an exception only. The flame should touch only the inside of the ring gear.

Following renewal of ring gear, the flywheel need not be balanced.

Renewal

1 Drill into old ring gear and break up with a chisel, or heat quickly and immediately remove.

2 Clean mounting surface of ring gear on flywheel.

3 Uniformly heat new ring gear on a hot plate or in a heating oven. For this purpose, use temperature measuring chalk in accordance with instructions whenever possible.

4 Mount heated ring gear immediately on flywheel.